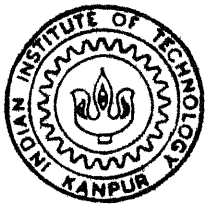
SHAPE DESIGN OF "SUNNY FR" SCOOTER CONSIDERING AESTHETIC AND ERGONOMICS ASPECTS

by

VIRENDRA JAIN



DEPARTMENT OF MECHANICAL ENGINEERING

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SHAPE DESIGN OF "SUNNY FR" SCOOTER CONSIDERING AESTHETIC AND ERGONOMICS ASPECTS

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by

VIRENDRA JAIN

to the

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APRIL, 1994

DEDICATED

TO MY

PARENTS

6.4.94

C E R T I F I C A T E

It is certified that the work contained in this thesis, entitled " Shape Design of Sunny FR scooter considering Aesthetic and Ergonomics Aspects", by Virendra Jain, has been carried out under our supervision and that this work has not been submitted elsewhere for a degree.

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A B S T R A C T

Two wheeler is one of the most popular mode of commutation in the present day transportations. Viewing the future demand, the scooter design is to become increasingly competitive. Anticipating this, Scooters India Limited, Lucknow, has proposed to improve the form and style of their product Sunny-FR scooter (100 c.c.) before launching it to market.

In this thesis an effort has been made to improve the form and style of Sunny-FR scooter by performing ergonomics and aesthetic study. The market research is done in which existing popular scooters in India are thoroughly studied. Comparisons are done for each of the major component of the scooter separately and the focus is given to ergonomics and aesthetic area. For the ergonomics study we have performed small experiments on the scooter. For the anthropometric data which are required for ergonomics study we have performed measurement studies on Humans. Through the comparative study the positive aspects of the scooters are incorporated in the Sunny-FR scooter. Improvements are integrated and blended in the existing model to achieve the improved design of Sunny-FR scooter.

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CHAPTER 1

INTRODUCTION

Two wheeler is one of the most popular mode of communications in the present day transportations. Scooters have occupied the most attractive position among the two wheelers among the middle class income group, for domestic use, office transportation, business and entertainment. Due to demand of fuel conservation, scooter is going to gain its popularity in developing as well as developed countries.

Viewing the future demand, the scooter design is to become increasingly competitive. Anticipating the future trend, innovation, attraction, comfort and efficiency are going to be some of the key components of scooter design. Sunny-FR scooter model, a product of Scooters India Limited, Lucknow (SCI) proposes to improve the form and style of the Sunny-FR scooter before launching it to the market. This thesis originated from an understanding between IIT Kanpur and Scooters India Ltd. to improve the existing Sunny-FR model. This thesis is a step towards the possible improvements of the design process. In the industry this part of design is called predevelopment and styling and may be innovative or evolutionary. In this case, design of the scooter exists. Moreover, operational, and technical details of the product are specified. Therefore, the design development is a matter of evolution from the previous model. Basic specification and features of the existing model are collected from the drawings and the model itself. These drawings and existing model of Sunny

FR scooter are made available to us by research and development department of SCI Lucknow. The market research is done in which the existing popular scooters are thoroughly studied. Through a comparative study some of the positive aspects are being compared in order to incorporate with new design form. In this thesis, we have focused our studies in the following two areas -

(i) To represent the market and user requirements in determining the ergonomics and appearance of the scooter.

(ii) To integrate market, user, and engineering requirements to make a better design.

Chapter 2 compares the features of the existing model of Sunny-FR model with other popular scooters on Indian roads. The discussion highlights some of the places for improvement of the existing design. Chapter 3 focuses on the ergonomics aspect of a scooter design based on Indian standard. All these factors are taken into consideration in modifying the existing scooter in Chapter 4. AUTOCAD is used to design and render three-dimensional views of the new scooter design. Finally, conclusions and extensions to this work are presented in Chapter 5.

CHAPTER 2

COMPONENTS AND ITS COMPARISONS

This chapter discusses various components of a scooter. The components of the existing Sunny-FR model are compared with other popular models those exist in the market. Figure 2.1 shows a view of a scooter highlighting different components. In the following, we describe each of the important components. The discussion is followed by the design in popular models and then the design in Sunny-FR.

Seat

All scooter manufacturers in India are shifting from a two-seat system to a single seat system. There are certain advantages :

(i) Rider as well as the person sitting behind the rider can adjust their seats according to their requirements. In India, scooter is considered to be a family vehicle and is, therefore widely used as a three-person vehicle, even sometimes a four-person vehicle with two children. With proper design of seat, at most four persons(with two children) can be more easily accommodated.

(ii) In many older scooters, the approach to the petrol tank is kept between the rider and passenger's seats. In new models with single seat for both rider and passenger, petrol tank is kept below the seat which can be approached easily after opening the seat-lock and lifting the seat(figure 2.3) . It is considered to

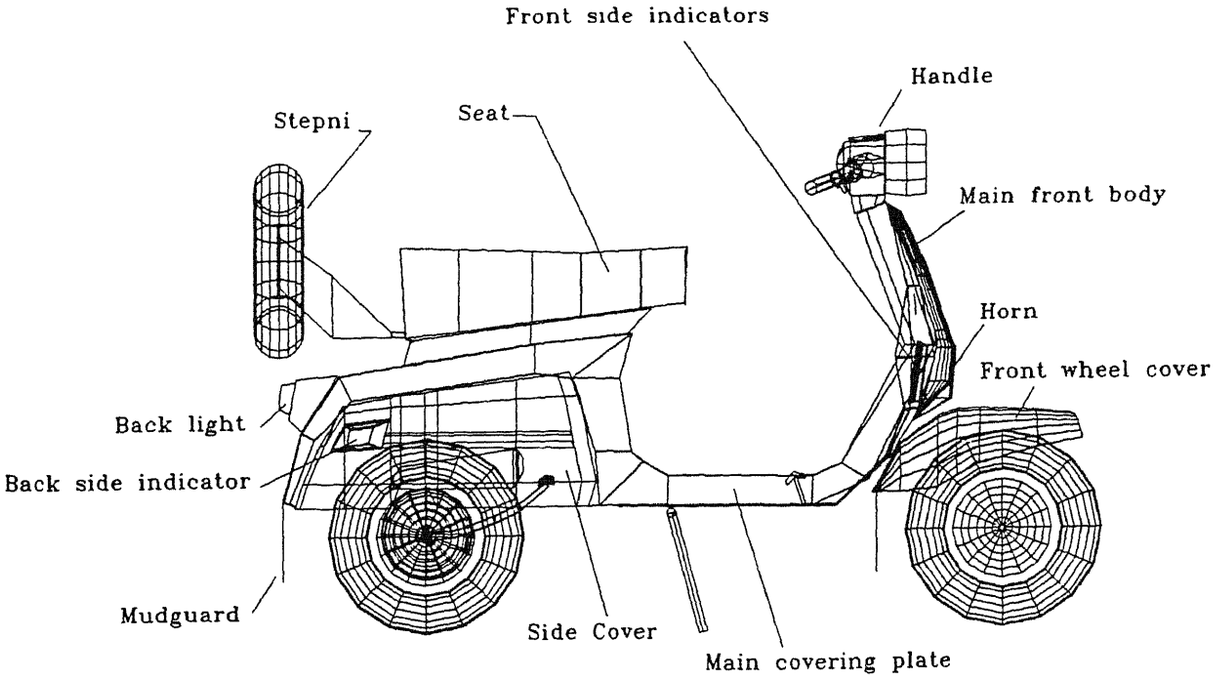


Fig. 2.1 Different components of scooter(Sunny-fr)

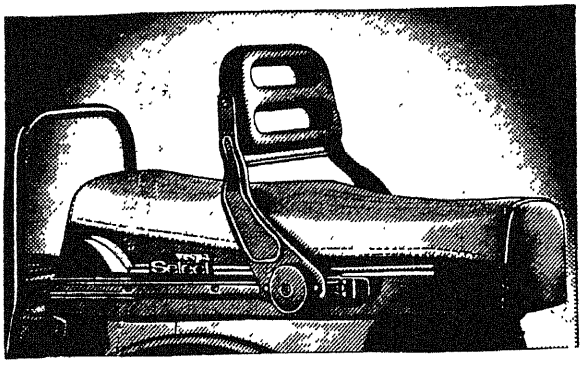


Fig. 2.2 Adjustable seat back rest

be a good design because, it also ensures the security of petrol tank. BAJAJ Auto Limited had shifted from two-seat system to single seat in all its new product, namely in Bajaj Super FE and Bajaj Sunny. KINETIC HONDA, the most popular scooter on Indian roads also has a single seat. LML NV SPECIAL and LML SELECT, the products of LML Limited, both have single seats. For more comfort, LML Limited has now incorporated the world's first adjustable seat back rest in its product LML SELECT (figure 2.2).

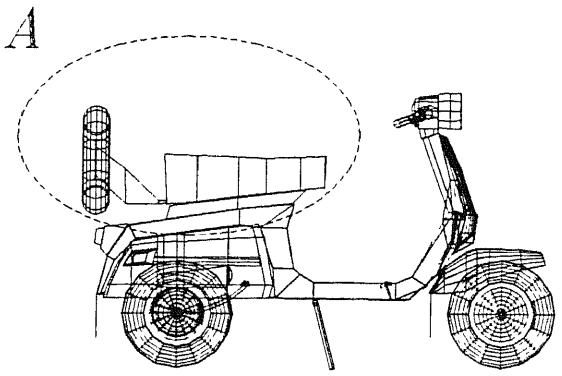
Existing sunny-FR model also has a single seat for both rider and passenger but there is a scope for improvement. The seat is smaller than the available space, thereby making a gap between the seat and the stepni (figure 2.3) unreasonably high. However, a little gap is essential for making the easy access of the seat lock, which can be achieved without reducing the seat length in two ways :

(i) By changing the support structure of the stepni.

(ii) By changing the position of the seat lock sideways, instead of its existing position at the back.

Side cover

'Side covers' on either side of the scooter protects the engine and the components from dust and simultaneously enhances the aesthetics of a scooter. The elegance of 'side-cover' design creates considerable visual impact on customers. Most of the existing scooters have bulging round side covers. For a typical example, side cover in most BAJAJ and LML models is shown in figure 2.4. But KINETIC HONDA has a different side cover which is beautifully made in a flow from the front of the scooter.



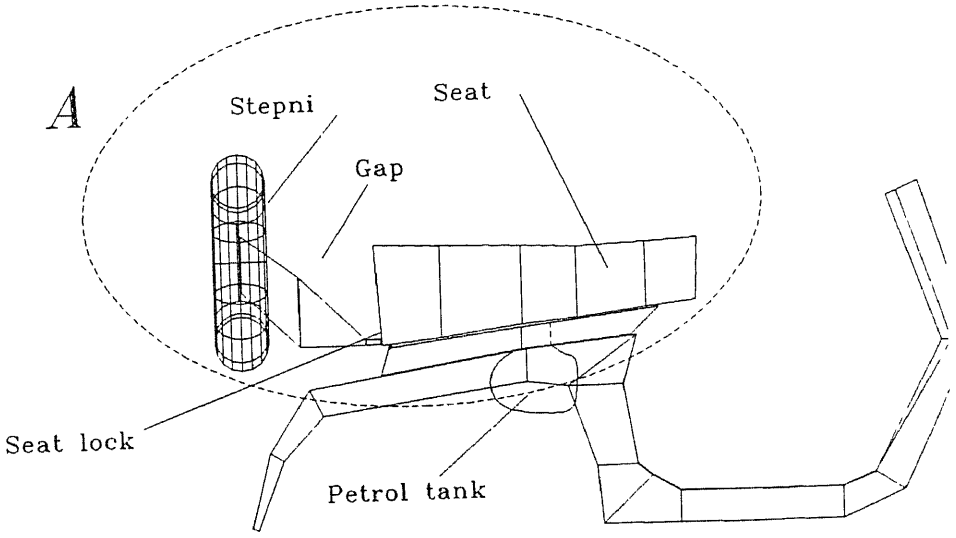


Fig. 2.3 Seat of Sunny-FR

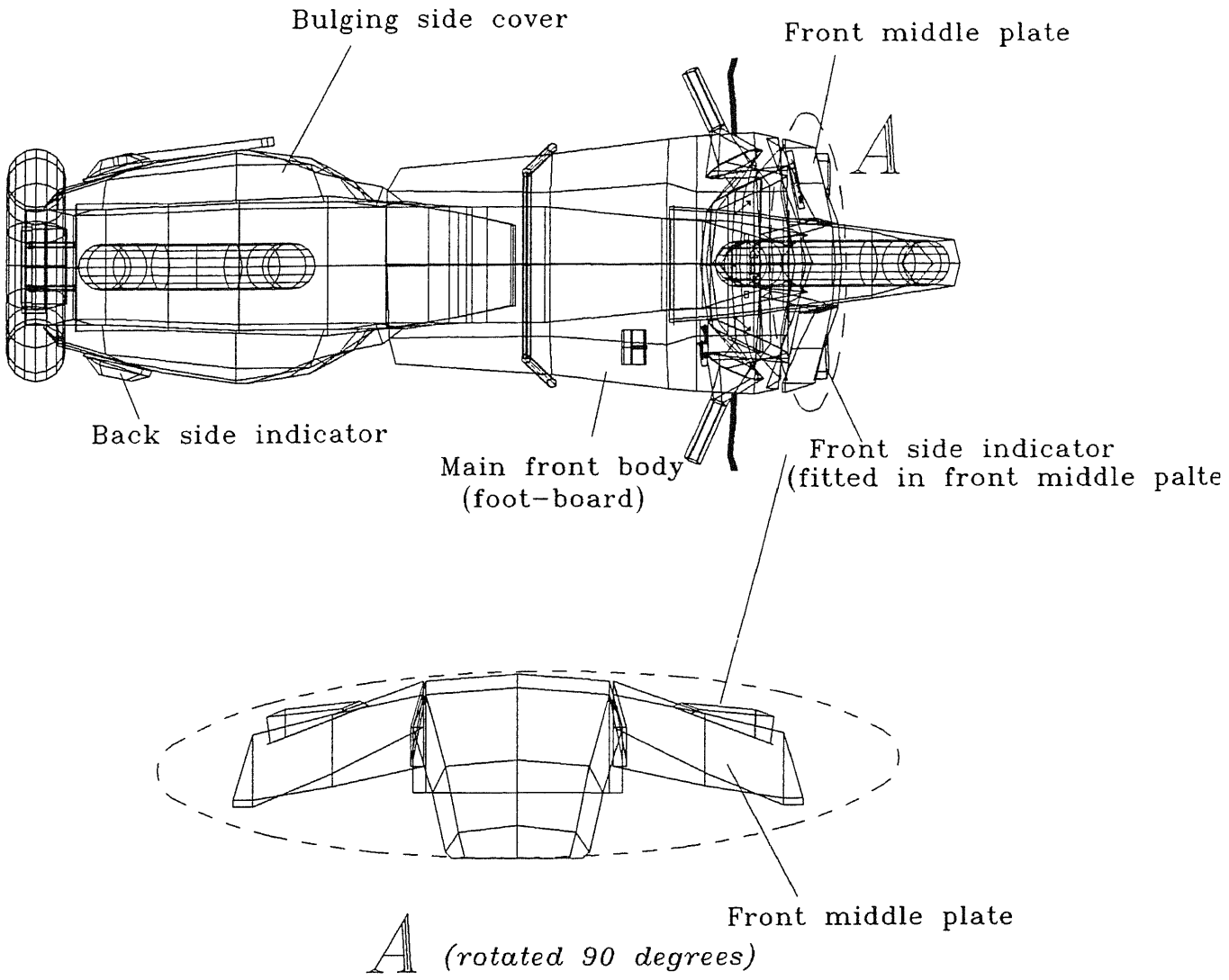


Fig. 2.4 Top-view of model 1 (like Bajaj scooter)

BAJAJ SUNNY(50 cc), like all other mopeds, has a small side cover which is not required to be removed for any repairment work.

SUNNY FR model has a flat curved side cover (figure 2.5), which do not balance with the rest of the body aesthetically in term of formal rhythm or dynamism. From the top-view it appears to be very thin as shown in the figure 2.5.

Front-cover

Front cover forms the most crucial part for the beauty of the scooter and also protects the rider from the gust of speed. It comprises of -

(i) Main front body,

(ii)Front wheel cover, and

(iii)Handle.

(i) MAIN FRONT BODY

In most scooters, the main front body extends up to the side cover so that it also forms the leg base for the rider (figure 2.6). The front view of the main front body in all BAJAJ scooters and LML scooters have a shape as shown in the figure 2.7. The isometric view of Sunny FR is shown in figure 2.8 to have a better picture of front part with rest of the scooter. In sunny FR the front portion is tapered at the top. In comparison with the front body, the handle looks relatively bigger. Main front body also has FRONT SIDE INDICATORS and HORN.

The position of front side indicator is very important as it should be seen from the widest possible range of angle. In older scooters front side-indicators are put in the MAIN FRONT BODY itself. In those cases lights were placed protruded outward to

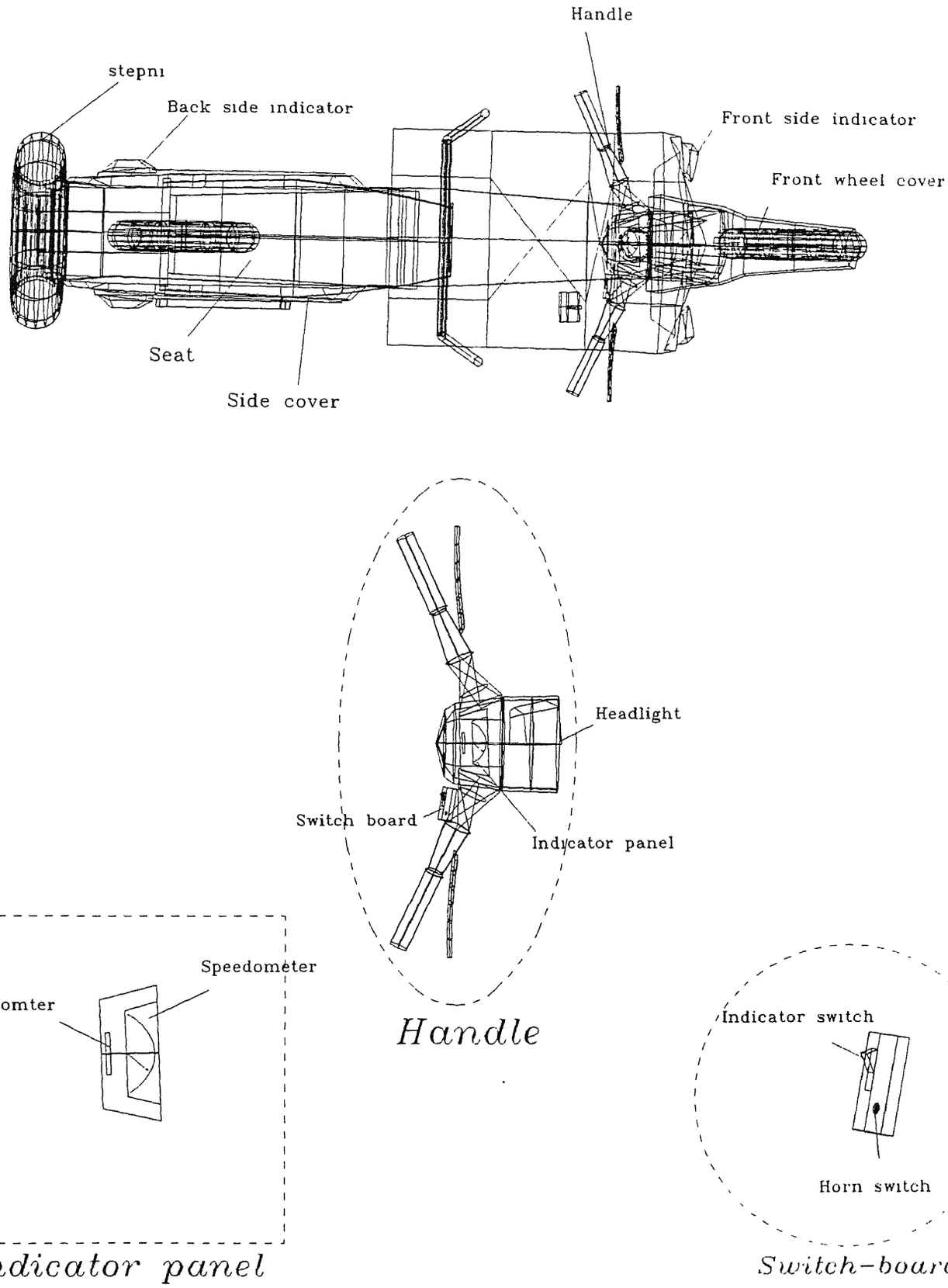


Fig. 2.5 Top-view of Sunny-FR

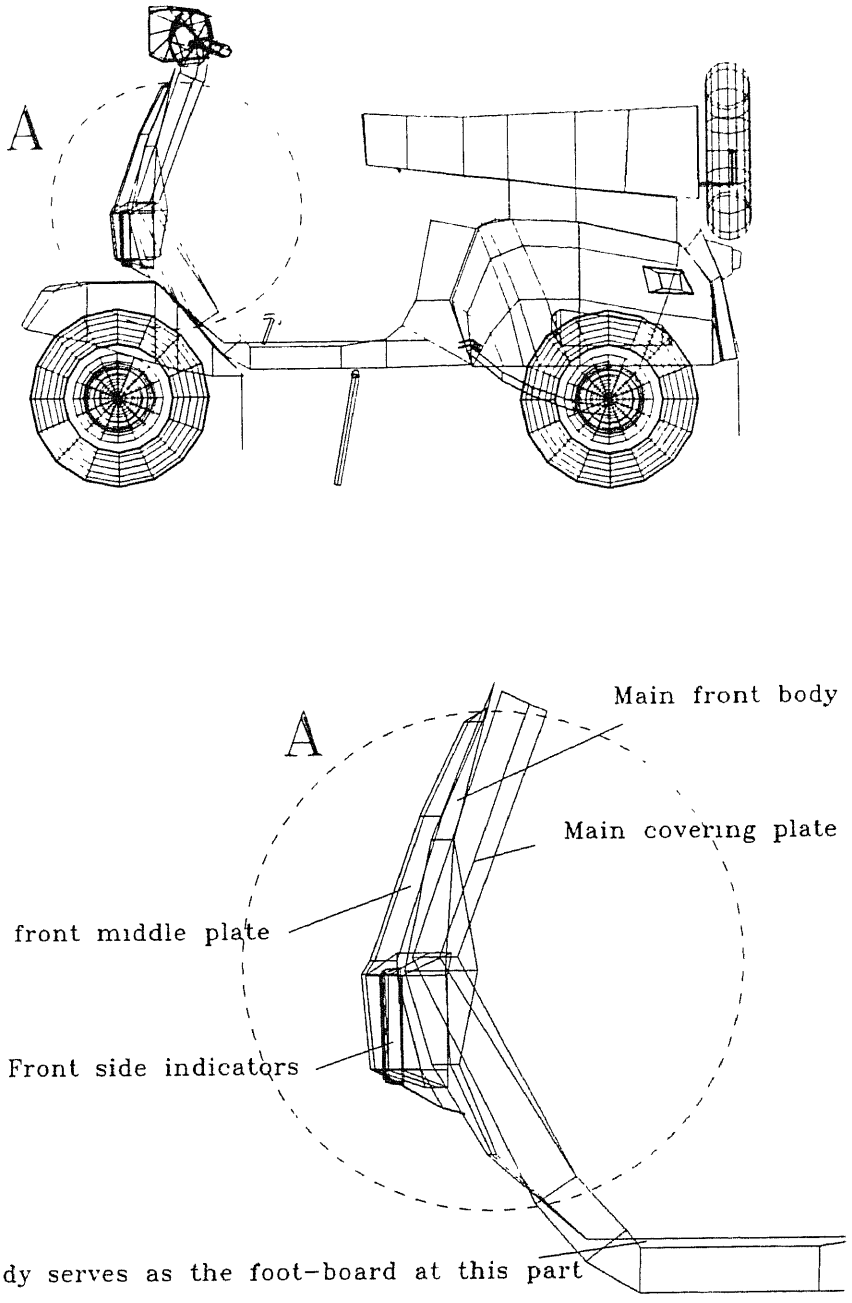


Fig. 2.6 Side view of model 1 (like Bajaj scooter)

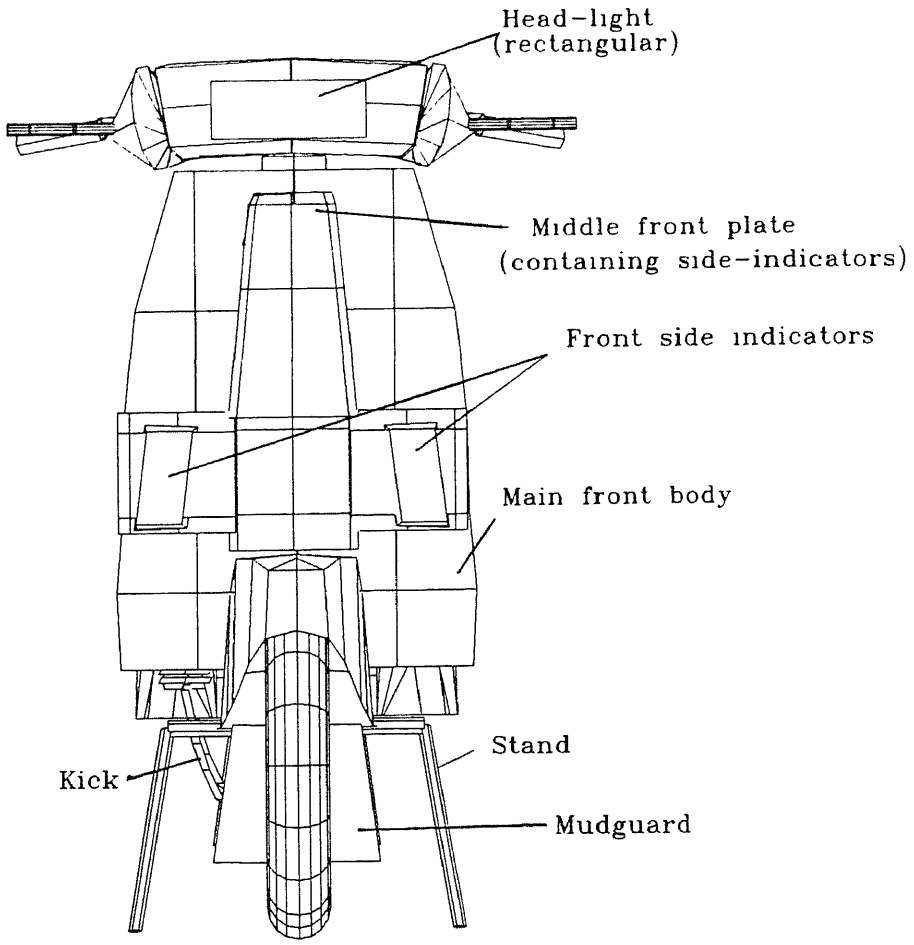


Fig. 2.7 Front view of model 1

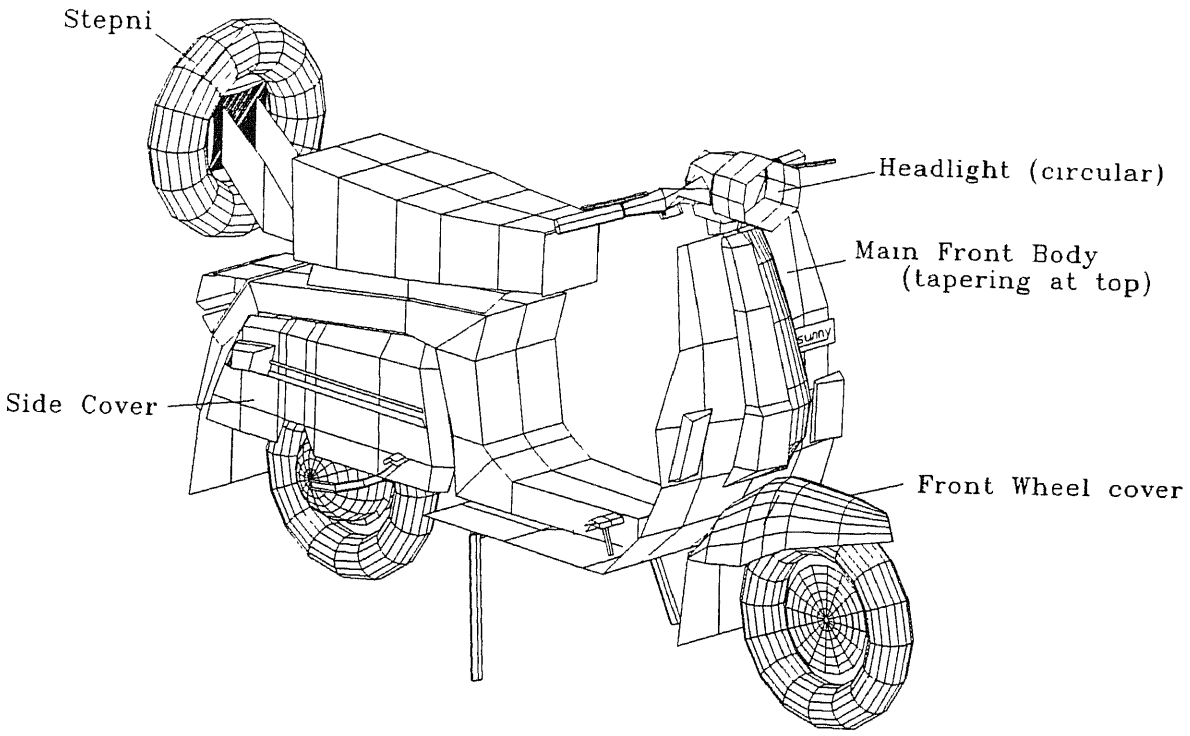


Fig. 2.8 Isometric view of Sunny-FR

increase the range of angle of sight. This makes the indicators highly vulnerable for breakage. Nevertheless, the protruded indicator lights are still used in some of the new models like LML VESPA NV SPECIAL, and BAJAJ CHETAK, including SUNNY-FR (figures 2.8 and 2.9). The other approach is to add an FRONT MIDDLE PLATE which has a higher slope sideways than the MAIN FRONT BODY. Side indicator lights are fitted inside this plate and need not to be protruded. Though this FRONT MIDDLE PLATE is also present in many existing scooters except KINETIC HONDA, it is mainly used to enhance the beauty. Therefore, no extra part is to be incorporated for doing this improvement. This improvement has been done in all the new products of the big companies like BAJAJ FE and LML SELECT as shown in figures 2.4 and 2.6. In KINETIC HONDA, however, front side indicators are incorporated in the handle along with the head-light. This is advantageous, because it automatically increases the view angle as the handle rotates (as the rotation of handle precedes the turning of vehicle).

(ii) FRONT WHEEL COVER

Front wheel cover acts as a guard towards mud, water or dust being thrown to the rider due to rotation of the front wheel.
It is always a separate part from the main front body and attached to the handle. They are usually of same style in almost all scooters with a little variation in shape. This part can swivel with the handle and therefore it should have clearing from the MAIN FRONT BODY as well as the MIDDLE FRONT PLATE. But the older model of Vijay Super scooter is an exception where wheel cover is not attached to handle but is attached to the main front body.

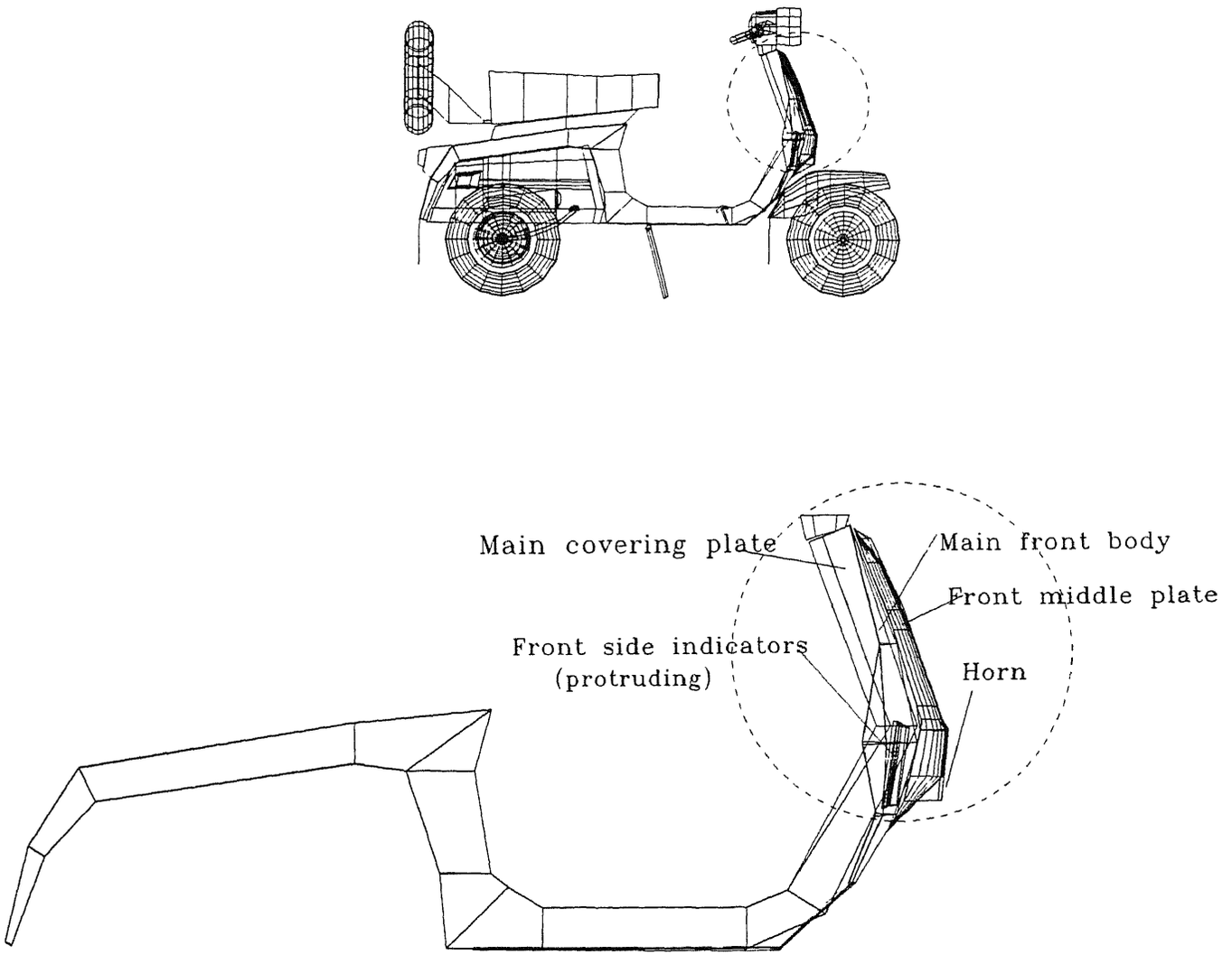


Fig. 2.9 Main front body of Sunny-FR

Therefore the wheel cover is fixed and thus the precision for clearance is not required. But as the wheel cover does not rotates along with wheel, the very purpose of wheel cover is not fully solved while turning of the vehicle. There is a shocker to minimize the shocks transferred to the riders from the road. One end of the shocker is attached to the wheel hub and other end is attached to the front wheel cover. When due to weight or unevenness of road the shocker is compressed, the distance between wheel circumference and wheel cover decreases. Therefore the distance of wheel cover from the wheel circumference is kept so that it exceeds the maximum shocker displacement.

As stated above, all the scooters have the same style of FRONT WHEEL COVER and SUNNY FR is no exception to it. The view for SUNNY FR is shown in figures 2.8 and 2.9. The only exception is KINETIC HONDA in which this part extends inside the MAIN FRONT BODY which have a sufficient clearance in the middle to take care of the turning of wheel.

(iii) HANDLE

Handle to a scooter is as important as a head to a man. It is not only the most crucial part from the aesthetics point of view, but it is also very important from ergonomics considerations. Since the rider has to hold the handles throughout his/her ride, the distance between left and right grips should be ergonomically designed.

All BAJAJ scooters, SUNNY FR, LML NV have typical handles with circular head light in the middle as shown in figures 2.8 and 2.5. LML SELECT has rectangular head light. The idea of

rectangular head-light is shown in figure 2.7. LML SELECT also have a small wind-shield at the upper portion which has no other purpose but to enhance the beauty of the look of the scooter. The handle in the KINETIC HONDA is different from that of all other scooters. Indicator panel has been enlarged for putting more indicators. The headlight and the front side indicators are placed side by side. BAJAJ have also adopted to this type of handle in its new model BAJAJ STRIDE.

Handle in the motor bikes are quite different and vary from bike to bike. Those models can also be used to improve the design of scooter handles as well.

Handle also contains switch-board which comprises of horn-switch, indicator-switch and headlight-switch. In SUNNY-FR scooter switch-board does not satisfies ergonomics requirements. In the model indicator panel contains only speedometer and milometer. Other important indicators like fuel indicator, dipper indicator are not provided. Top view of the handle and seperate views of indicator panel and switch-board of SUNNY-FR are shown in figure 2.5.

Main covering plate (chases)

This plate runs from the handle to the tail of the scooter. As it takes the load of the scooter and supports all the other parts of the scooter including the riders, it can rightly be called the chases of the scooter. It covers the delicate parts like clutch wires, gear wires, electric wire connections too. In all the existing scooters it is almost of the same style with a little change in shape. As all the other parts of scooter is

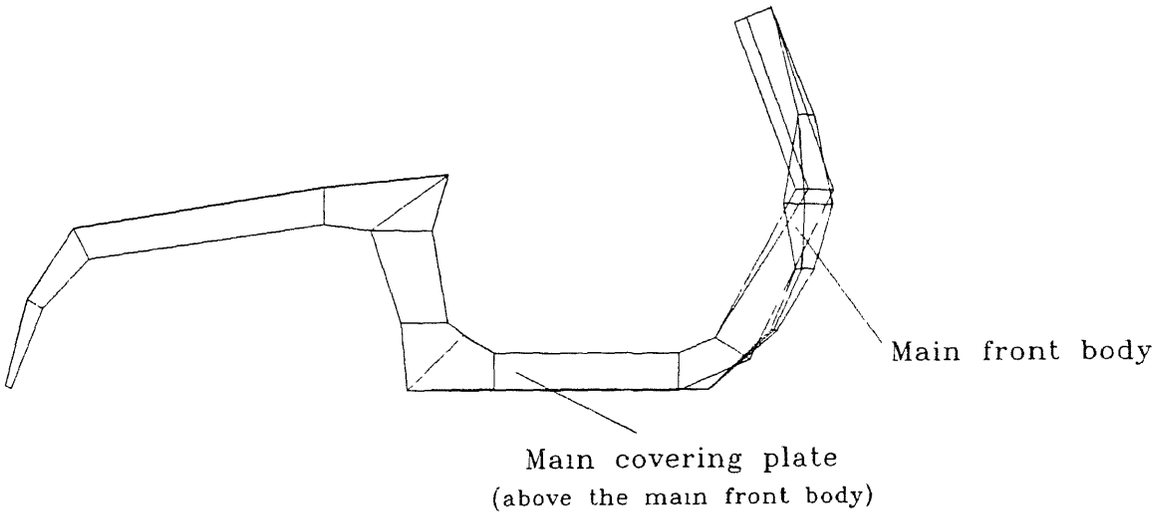
directly or indirectly attached to it, its shape becomes the constraining factor on the shape of the whole scooter. This part is semicircular near the handle from where it starts flattening and takes the trapezoidal shape in the foot-board zone and rectangular shape on the seat base.

As seen from the figure 2.10, FRONT MAIN COVER is in the front of MAIN COVERING PLATE and as the former extends, it moves below the later. This FRONT MAIN COVER forms the foot-board in its extended horizontal portion over which lies the brake pedal. All the LML,BAJAJ and SUNNY FR have the above mentioned type of MAIN COVERING PLATE, but in KINETIC HONDA brake pedal is not required and the MAIN FRONT COVER extends above the MAIN COVERING PLATE. This makes the complete leg base flat making it more comfortable as well as suitable for keeping luggage etc. This idea is shown in figure 2.6.

Stepni

Puncture in wheel tyres is one of the most common problems in any vehicle on roads. The rider cannot do much about the conditions of the road. Therefore to take care of this problem a spare wheel, which can be substituted for the punctured wheel, is kept in the scooter. This spare wheel is also called stepni. Stepni can be put into the scooter in three ways :

(i) As in all BAJAJ models, KINETIC HONDA and SUNNY FR, the stepni is placed at the back of the seat. In this style, it also gives support to the person sitting at the back. Aesthetically this style makes the scooter more soothing. In designing a stepni, care should be taken to have an easy lodging and dislodging of the



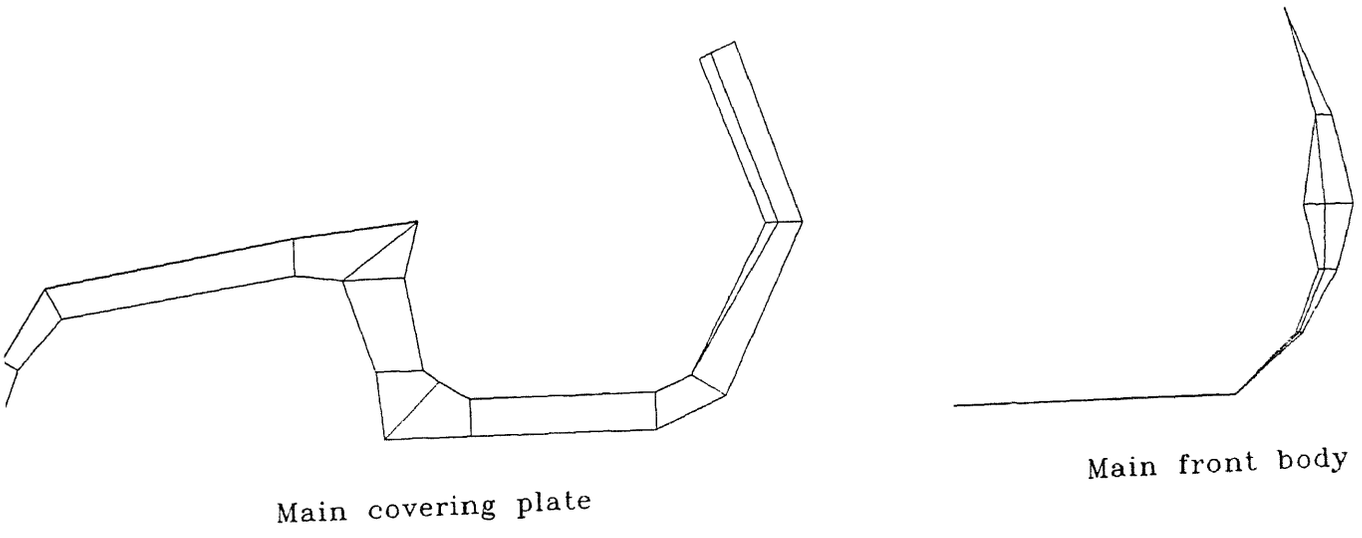


Fig. 2.10 Main covering plate of Sunny-FR

extra wheel (figure 2.8 and figure 2.9).

(ii) Stepni can also be placed inside the SIDE-COVER as in LML NV SPECIAL and LML SELECT.

(iii) Stepni can be placed behind the MAIN FRONT PLATE, as in BAJAJ SUNNY 50 cc scooter.

Conclusions

This chapter described major components of a scooter. Components of the existing Sunny FR model have been compared with most popular Indian scooters. The shortcomings in the design of Sunny FR are also mentioned. These factors will be incorporated later in the thesis in the design of an improved model. In next chapter, an ergonomics study of the existing Sunny FR model is performed and improvements, if any, are suggested.

CHAPTER 3

ERGONOMICS FACTORS

In the era of competition where the customers have variety of choices, manufacturers cannot neglect the ergonomics factors. Comfort and efficiency of the customer is the main purpose of ergonomics study. The study is necessary for the safety and for the efficient utilisation of the facilities provided in the vehicle. The science of measuring the body is anthropometry. In U.S., a great share of anthropometric data has been generated for the purpose of design related information. The designer has to refer anthropometric data whenever a design involves a "fit" problem. These data are not available for Indian standard. Therefore, the anthropometric data are taken from following books published from U.S.-

(i) Human Factors and Design Handbook by Wesley E. Woodson.

(ii) Proceedings of Symposium on sitting postures by E. Grandjean.

These data have been collected according to the population groups(agewise) in United States of America. These data are then modified according to Indian population through surveys and experiments.

We had considered different components separately to illustrate the effect of ergonomics in more detail.

Brake pedal

Since brake pedal requires some amount of force, the geometric relationship between the operator's leg and foot and the

position and the angle of the pedal are important considerations. Depending on the height of the seat, not only must foot pedal be placed within the reach, but also must operate in a direction that is compatible with the force application factor so that the least amount of force is required. Other factors must also be considered like the driver should always be able to rest his or her heel on the floor. The pedal should be big enough so that all size of drivers can press the pedal with the front of the foot.

The seat distance from the foot pedal-base(foot-board) has been compiled on the basis of anthropometric study in the subheading "seat" later in this chapter. The horizontal distance of the brake pedal from the seat found suitable through experiments is 7.2 inches which matches with that of existing style of Sunny-FR model (figure 3.1). The height of the pedal from the foot board needs to be about 2.4 inches. The optimum angular relationship between the lower leg and the pedal surface plane should be approximately 90 degrees as shown in figure 3.1.

Handle

Many factors have to be considered in case of handle. It is the most important part in this study. Driver should feel comfortable while riding the scooter. The horizontal and vertical distance of the handle from the seat, the height of the handle from the foot-board, its horizontal and vertical inclination are important dimensions to be considered. The size of handle is important both in ergonomics and aesthetic study. We will take each of these factors separately.

VERTICAL DISTANCE OF HANDLE FROM SEAT - For this we refer to

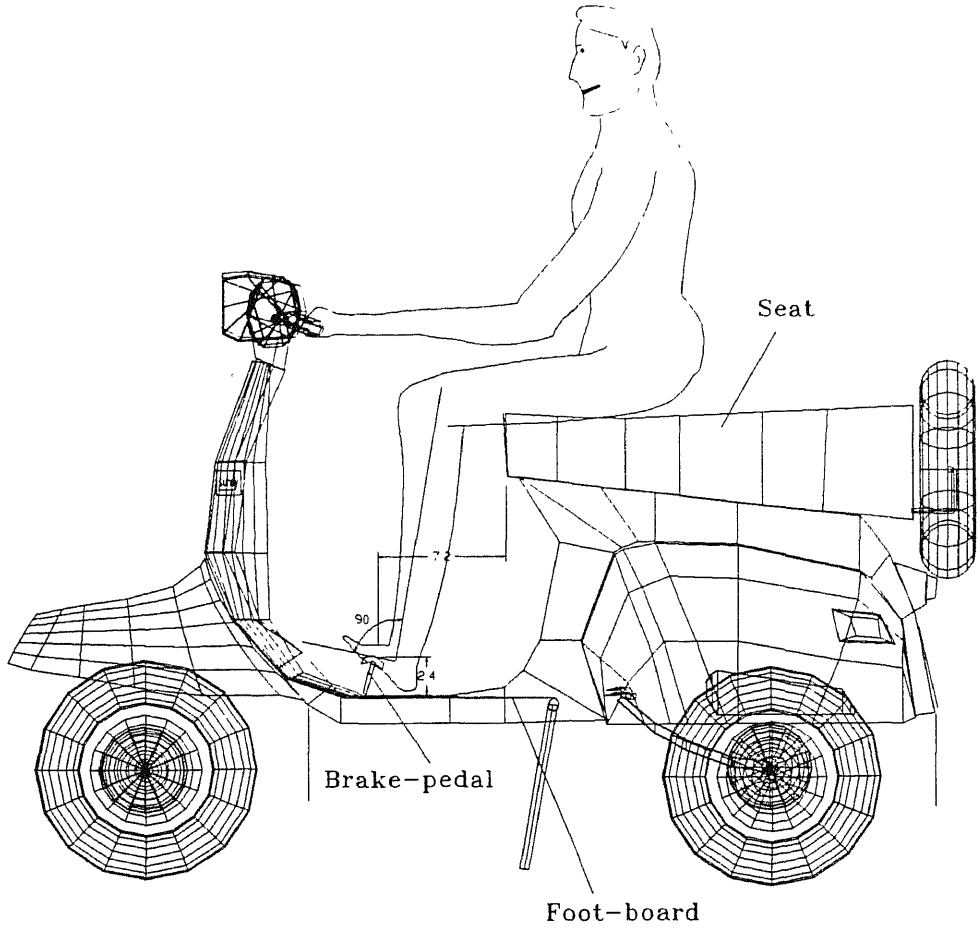


Fig. 3.1 Ergonomics study of Brake-pedal

anthropometric data of mid shoulder height (vertical distance of shoulder from seat while sitting) from the table 3.1. From the table we take the average 5th and 95th percentile of adult males. Therefore the midshoulder height (x) is equal to (21+25)/2 = 23 inches(see figure on page 25). These data are taken for the U.S. population whose average height is more than that of Indians. Therefore, we take (x) equal to 21 inches for Indians. Through experiments we find the average shoulder to elbow length (y) equal to 12 inches(see figure 3.2). But while riding, (y) does not remains vertical and for an average person it makes an angle of 30 degrees from the vertical. Therefore the vertical measure of average shoulder to elbow length is 12 * cos30 =10.5 inches. We feel greatest comfort when our arm is horizontal. Thus the vertical distance of the handle from the seat should be 21-10.5 = 10.5 inches(see figure 3.2). In our existing model this height comes to be 9.5 inches which is 1 inch less than our calculated value.

HORIZONTAL DISTANCE OF HANDLE FROM SEAT - We compiled data for the average fore-arm length of a grown Indian man. Through experiments we found that for an average grown Indian, elbow to mid palm distance is about 14 inches. In the existing scooter models, the arm of the rider is not parallel to the line of the scooter. From the functional comfort point of view it is found by experiments that 15 degree may be the ideal angle for the average Indians. Thus the horizontal distance from the rider's shoulder to the handle should be 14 * cos 15 =13.5 inches(see the highlighted area of figure 3.2).

The size of the handle should be in accordance with other

MIDSHOULDER HEIGHT (SITTING)

This dimension is pertinent to the location of controls (i e , most controls should not be located above the shoulder) and to the location of the anchor point for seat belts (i e , the belt should not depart aft of the shoulder horizontally or at a negative angle, otherwise it will create discomfort and tend to push the occupant downward during a frontal-impact crash)

	Percentile		
	5th	50th	95th
Adults			
Males	21 0 in	—	25 0 in
Females	18 0 in	—	25 0 in
Boys			
Age 17	—	—	—
Age 14	18 1 in	20 1 in	21 2 in
Age 12	17 8 in	19 4 in	21 5 in
Age 6	13 7 in	15 4 in	17 0 in
Age 2	11 1 in	12 3 in	13 3 in
Girls			
Age 17	—	—	—
Age 14	19 1 in	21 2 in	22 6 in
Age 12	17 6 in	19 5 in	21 0 in
Age 6	13 6 in	15 1 in	16 5 in
Age 2	11 1 in	12 3 in	14 0 in
Adults age 70 and over			
Males	20 9 in	24 0 in	27 2 in
Females	—	—	—
Truck and bus drivers			
Males	21 2 in	24 3 in	27 5 in
Females	—	—	—
Airline pilots	—	—	—
Flight attendants (Female)	20 1 in	22 9 in	25 7 in
Law enforcement officers			
Males	—	—	—
Females	—	—	—

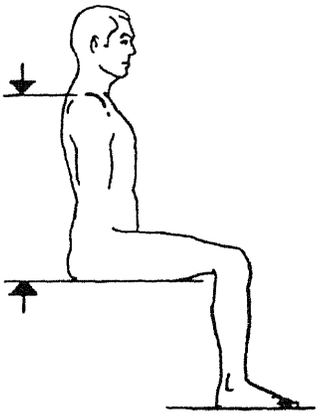


Table 3.1 Midshoulder height (sitting)

(reference Human factors and Design Handbook)

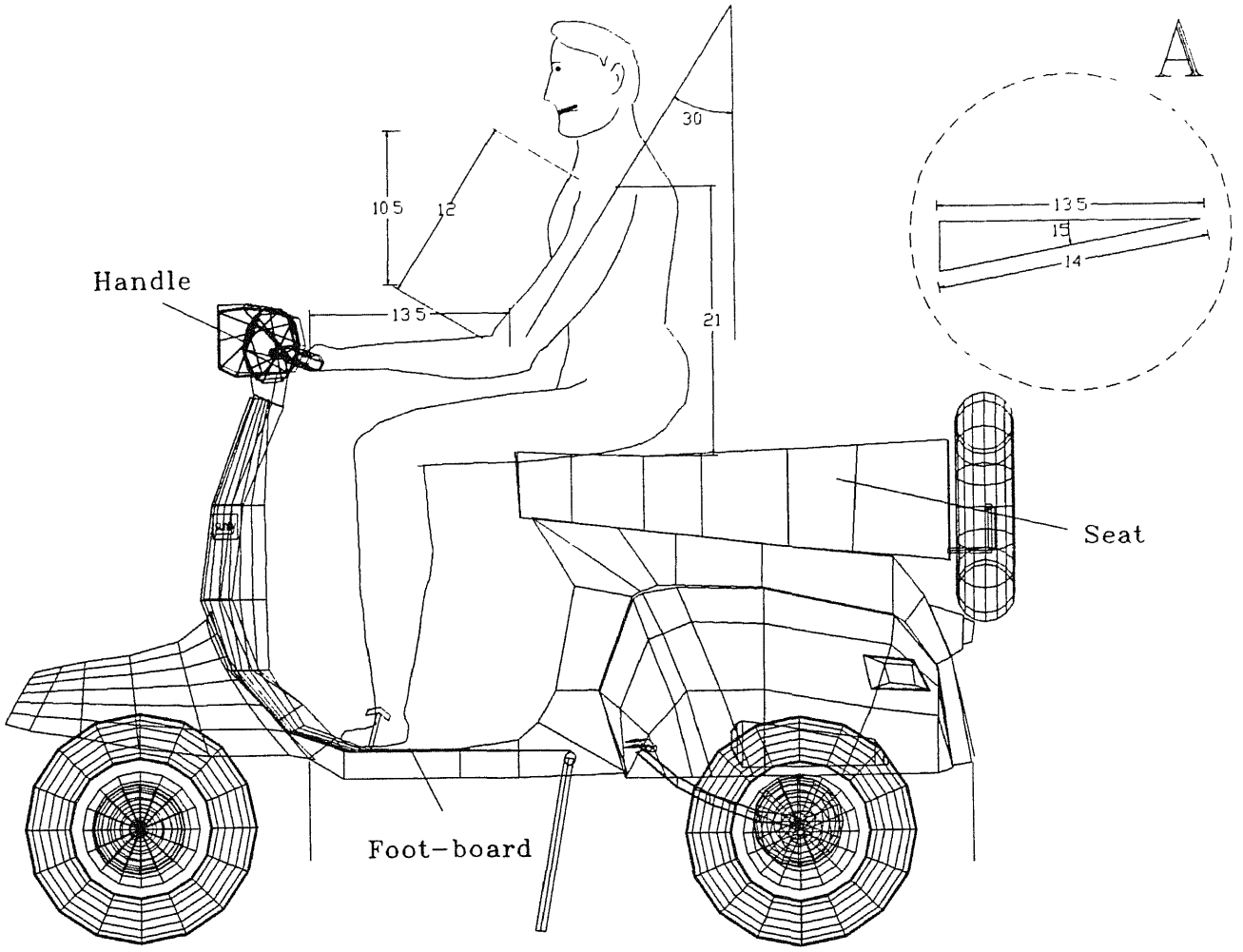


Fig. 3.2 Ergonomics study of seat and handle positions

parts of the scooter. By trial and error method we found that the most suitable length of the handle of the scooter is 25 inches (figure 3.3). The existing scooter handle size is 25.5 inches which is quite close to our designed value.

Along the line of handle size and design various other parts related to the handle are having their own function and importance. The study includes these parts also.

The accelerator, which is cylindrical in shape, its circumference and length should be in accordance with the anthropometric data. Hand length data is given in table 3.2. The data for 50th percentile for adult males is 7.6 inches. But in gripping the accelerator only x portion of hand is used(see figure on page 29), and the study measurement shows it to be approximately 6.5 inches. Thus circumference of the accelerator should be equal to 6.5 inches. Therefore the diameter of the accelerator 6.5/3.14 = 2.3 inches. The length of the accelerator should be a little more than hand breadth at metacarpal. This data is shown in table 3.3. For adult males the data for 50th percentile is 3.4 inches. In the existing scooter, the diameter and length of the accelerator are 1.5 inches and 4.75 inches respectively (figure 3.3).

In the existing model of Sunny-FR, no inclination is given to the headlight. But for better focus of light on road, headlight should be inclined to the horizontal by 5 degrees as found through experiments. This is an important consideration for the safety point of view because this inclination not only illuminates the path better but also avoids direct focus of light at the eyes of

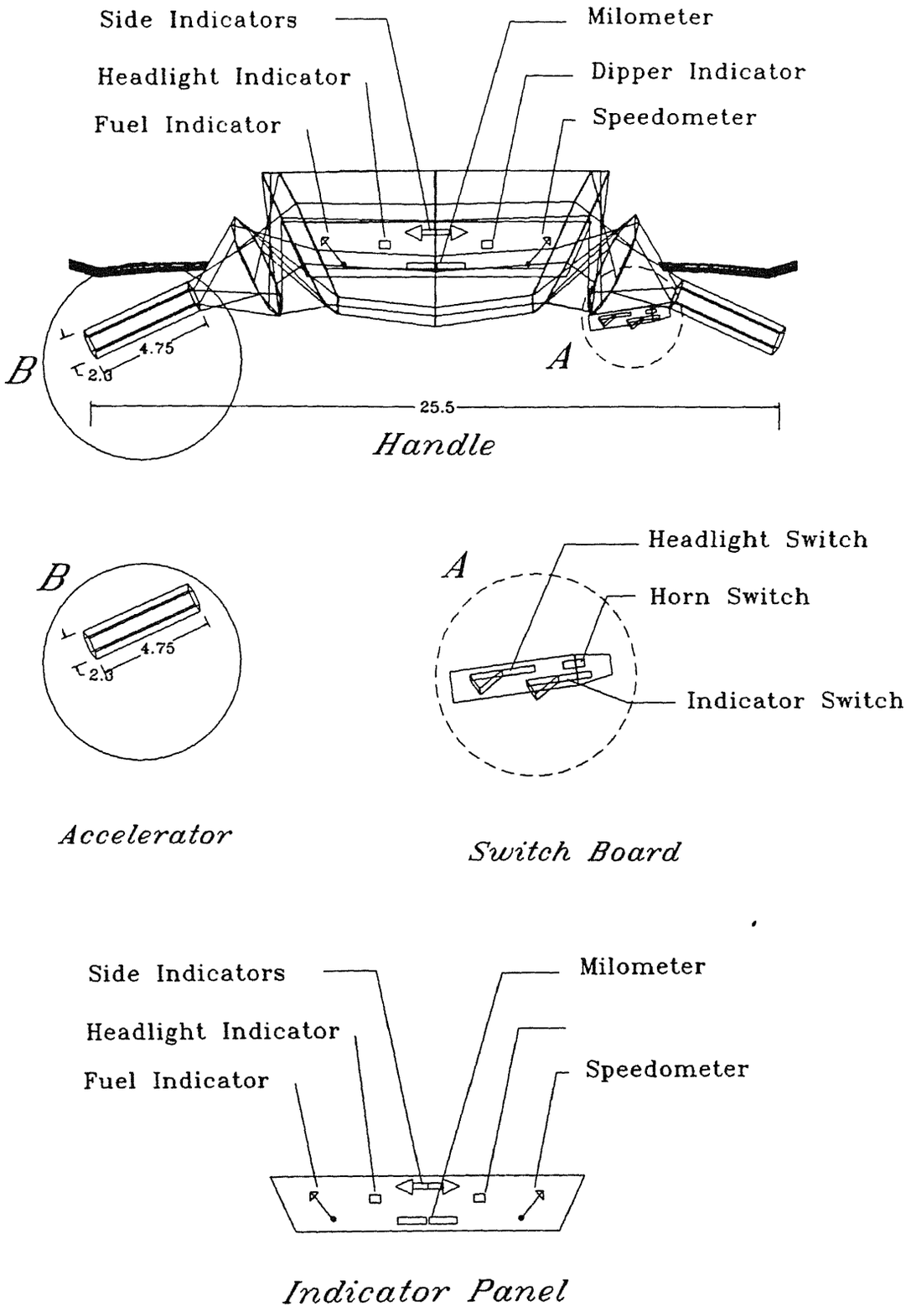
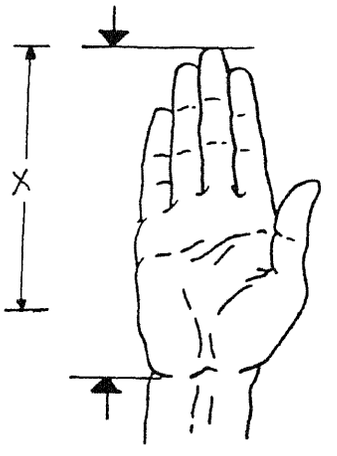


Fig. 3.3 Ergonomics study of Indicator panel, Switch-board

HAND LENGTH

This dimension is pertinent to the design of gloves mittens and other devices for protecting the hands This dimension is also useful in selecting test subjects for evaluating hand-held or hand-manipulated devices such as handrails and gun and joy-stick grips



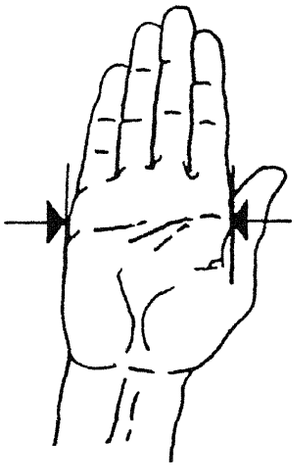
	Percentile		
	5th	50th	95th
Adults			
Males	7 0 in	7 6 in	8 2 in
Females	6 4 in	6 9 in	7 4 in
Boys			
Age 17	6 8 in	7 4 in	7 9 in
Age 14	6 3 in	7 0 in	7 6 in
Age 12	5 7 in	6 3 in	7 0 in
Age 6	4 6 in	5 0 in	5 7 in
Age 2	3 6 in	3 9 in	4 2 in
Girls			
Age 17	6 1 in	6 7 in	7.2 in
Age 14	6 1 in	6 7 in	7.2 in
Age 12	5 6 in	6 4 in	7 0 in
Age 6	4 5 in	4 9 in	5 4 in
Age 2	3 3 in	3 8 in	4 3 in
Adults age 70 and over			
Males	7 0 in	7 4 in	8 0 in
Females	—	—	—
Truck and bus drivers			
Males	7.1 in	7 6 in	8 0 in
Females	—	—	—
Airline pilots (Male)	6 9 in	7 5 in	8 0 in
Flight attendants (Female)	6 3 in	6 8 in	7.3 in
Law enforcement officers			
Males	7.0 in	7 6 in	8 2 in
Females	—	—	—

Table 3.2 Hand length

(reference Human factors and Design Handbook)

HAND BREADTH AT METACARPAL

This dimension is pertinent to the design of hand protective gear



	Percentile		
	5th	50th	95th
Adults			
Males	3 1 in	3 4 in	3 8 in
Females	2 7 in	3 0 in	3 4 in
Boys			
Age 17	3 2 in	3 5 in	3 7 in
Age 14	2 8 in	3 2 in	3 6 in
Age 12	2 6 in	2 9 in	3.3 in
Age 6	2 1 in	2 4 in	2 6 in
Age 2	1.7 in	1 9 in	2 2 in
Girls			
Age 17	2.7 in	2 9 in	3 3 in
Age 14	2 7 in	2 9 in	3 2 in
Age 12	2 5 in	2 8 in	3 1 in
Age 6	2 0 in	2 3 in	2 5 in
Age 2	1 6 in	1.8 in	2 1 in
Adults age 70 and over			
Males	3 1 in	3 3 in	3 6 in
Females	—	—	—
Truck and bus drivers			
Males	3 2 in	3 5 in	3 8 in
Females	—	—	—
Airline pilots (Male)	3.2 in	3 5 in	3 8 in
Flight attendants (Female)	2 7 in	2 9 in	3 1 in
Law enforcement officers			
Males	3 3 in	3 5 in	3 8 in
Females	—	—	—

Table 3.3 Hand breadth at metacarpal

(reference Human factors and Design Handbook)

the persons coming from front (figure 3.4).

The indicator panel should be placed at an angle suitable for easy visibility to the rider. It is found through experiments that the best inclination of the indicator panel in the handle is 9 degrees from the horizontal. In the existing model of Sunny-FR scooter the angle is 7 degrees , which should be increased to 9 degrees in the new design. In most of the new models of the scooter, the indicator panel comprises of speedometer, milometer, fuel indicator, side light indicator, dipper and headlight indicator. In the existing Sunny-FR model, the panel is small and contains speedometer and milometer only(figure 2.5). For better efficiency, fuel indicator, side light indicator and dipper indicator should also be incorporated in the indicator panel. (figure 3.3).

From the ergonomics point of view, the positions of the indicator switch, dipper switch and horn button form a very important role. They should be easily accessible by the thumb while the driver has gripped the accelerometer by his palm. Thus the distance of the switches from the accelerator and their angular position on the handle are the prime considerations. Horn is more frequently used than others, therefore its position should be kept nearest to the palm grip so that other switches do not interfere when the horn is used. In the existing model, the switch-board comprising these three switches, makes 45 degrees from the horizontal. By experimenting on the existing model we find that for the most comfortable position this angle should be 10 degrees. Furthermore, the most suitable placement of these switches are also found by experimentation and this is shown in

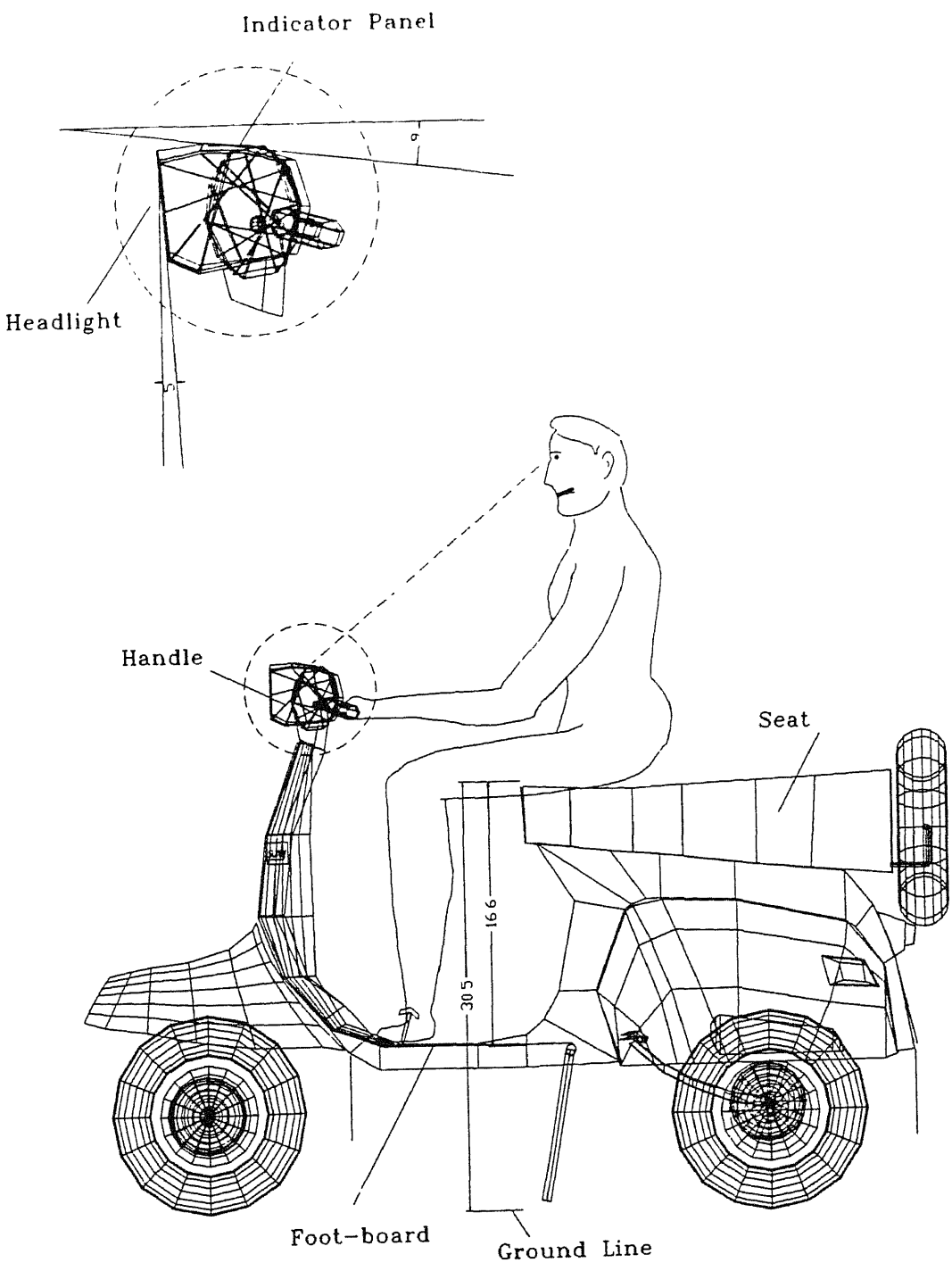


Fig. 3.4 Ergonomics study for seat placement(vertical) Headlight angle and Indicator panel angle

figure 3.3. The size of horn button is too small in comparison to the normal size of the thumb in the existing model(figure 2.5). Observing no advantage of a small button we may shift to a larger button of rectangular size. This will make it equally comfortable for the drivers having larger palms as well as those having smaller palms.

Seat

Seat should be comfortable for the persons sitting on it. The comfort of the seating gesture would reflect in driver's performance to do certain other activities. Therefore, the seat should be positioned in such a manner that the driver should be able to function with ease. The best position of the seat is found on the basis of anthropometric data of the following dimensions.

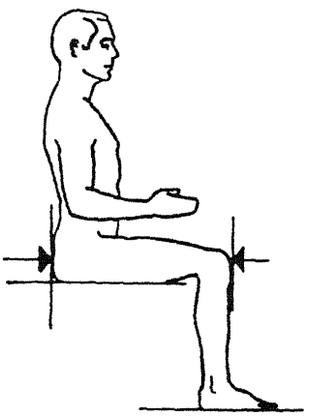
(i) Buttock to knee length.

(ii) Popliteal height (sitting).

First of all, we considered anthropometric data of buttock to knee length. This dimension is pertinent to establishing knee clearance for the seated driver. This data has been shown in table 3.4 and is equal to 22.6 inches for 50th percentile for grown adult. The data has been taken from literature on american population. For Indians, the dimension will be comparatively shorter than standard Americans. We take this dimension equal to 22 inches. But while riding the scooter, the buttock to knee length portion of an average person by an angle of 15 degrees from the horizontal. Therefore, the horizontal measure of buttock to knee length of rider while riding the scooter is 22 * cos 15 = 20

BUTTOCK-TO-KNEE LENGTH

This dimension is pertinent to establishing knee clearance for the seated operator. It should be used in conjunction with knee-height and thigh-clearance dimensions



	Percentile		
	5th	50th	95th
Adults			
Males	21 3 in	23 3 in	25.2 in
Females	20 4 in	22.4 in	24.6 in
Boys			
Age 17	21 2 in	23.1 in	25 0 in
Age 14	19.2 in	21.4 in	23 5 in
Age 12	17 7 in	19.5 in	21.5 in
Age 6	12 9 in	14.1 in	15.6 in
Age 2	8 5 in	9 3 in	10 5 in
Girls			
Age 17	20.0 in	21.7 in	23.5 in
Age 14	19.4 in	21.2 in	23.2 in
Age 12	17.9 in	20 1 in	22.0 in
Age 6	12.5 in	14 2 in	15 4 in
Age 2	7 4 in	9.4 in	10 6 in
Adults age 70 and over.		✓	
Males	21 0 in	22 6 in	24.4 in
Females	19 9 in	22.2 in	23 9 in
Truck and bus drivers			
Males	22.7 in	24 6 in	26 8 in
Females	20 6 in	22 9 in	24 9 in
Airline pilots (Male)	22 0 in	23 6 in	25 6 in
Flight attendants (Female)	21 2 in	22 6 in	24.2 in
Law enforcement officers			
Males	22 6 in	24 2 in	26 1 in
Females	—	—	—

Table 3.4 Buttock to knee length

(reference Human factors and Design Handbook)

inches (figure 3.5). Through a study, we find that an average person occupies 12 inches of seat. Therefore the distance of the seat from the front should be greater than (y), where y equal to 20 - 12= 8 inches(see figure 3.5). In the existing model, the distance between the seat and the front plate is 16 inches providing 16-8= 8 inches extra knee clearance as shown in figure 3.5.

Once we had found the horizontal position of the seat with respect to the front plate of the scooter, we have to find the vertical position of the seat with respect to some datum. Therefore, it is required to use the anthropometric data of popliteal height(sitting). The dimension is pertinent to the establishment of appropriate seat height. This dimension is also pertinent to establish the relation between a vehicle seat and foot controls. From the table 3.5 we get this data equal to 16.6 inches for 50th percentile for grown adult. In the existing scooter, this height is 17 inches, which seems to be quite satisfactory according to our design (figure 3.4). We perform another experiment to check that the seat is at the appropriate height from the ground. By survey we find the anthropometric data of the distance from knee to the upper end of thigh is 31 inches. The height of the seat from the ground should be less than 31 inches because when the driver tries to get the support by putting his feet on the ground, his legs are not vertical. We give allowance for this of 0.5 inches. Thus the height of the seat from the ground should be 30.5 inches. We see that the existing scooter satisfies this design criteria as shown in figure 3.4.

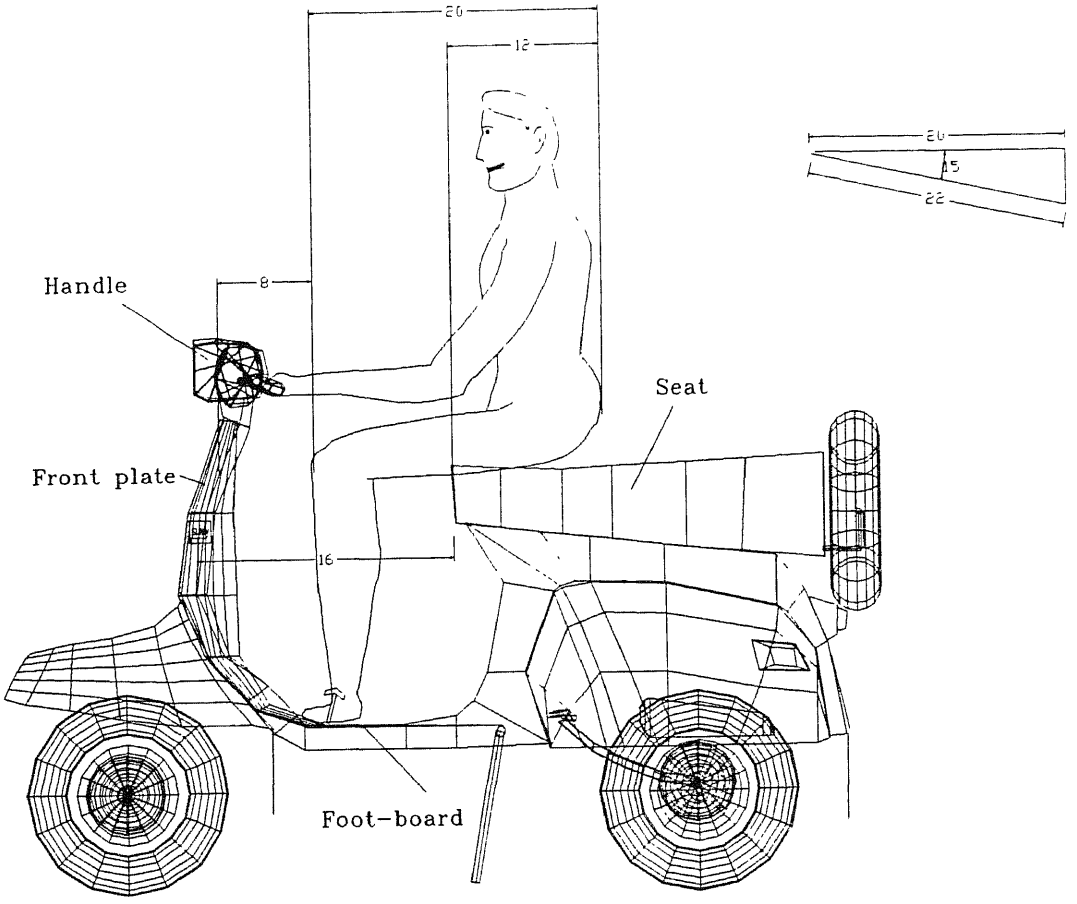
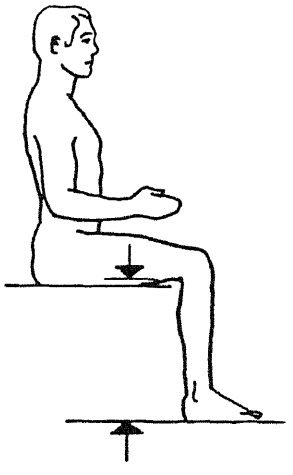


Fig. 3.5 Ergonomics study for seat placement(horizontal)

POPLITEAL HEIGHT (SITTING)

This dimension is pertinent to the establishment of appropriate seat heights It is also pertinent to the selection of test subjects who will be used to evaluate the relationships between a vehicle seat and foot controls



	Percentile		
	5th	50th	95th
Adults			
Males	15 5 in	17 3 in	19 3 in
Females	14 0 in	15 7 in	17 5 in
Boys			
Age 17	—	—	—
Age 14	—	—	—
Age 12	13 2 in	14 6 in	16 1 in
Age 6	10 4 in	11 5 in	12 6 in
Age 2	—	—	—
Girls			
Age 17	—	—	—
Age 14	—	—	—
Age 12	13 0 in	14 7 in	16 3 in
Age 6	10 2 in	11 3 in	12 5 in
Age 2	—	—	—
Adults age 70 and over			
Males	15 2 in	16 6 in	17 9 in
Females	13 5 in	15 6 in	17.2 in
Truck and bus drivers			
Males	15.7 in	17.5 in	19 7 in
Females	—	—	—
Airline pilots (Male)	15 7 in	17.0 in	18 2 in
Flight attendants (Female)	15.9 in	17.1 in	18 5 in
Law enforcement officers			
Males	—	—	—
Females	—	—	—

Table 3.5 Popliteal height (sitting)

(reference Human factors and Design Handbook)

Conclusion

In this chapter ergonomics study is done and the appropriate dimensions of the scooter are calculated. These appropriate data are incorporated in the improved design which is done in the following chapter.

CHAPTER 4

AN IMPROVED DESIGN

After performing the ergonomics and aesthetic study of the existing model, we found out that there are many shortcomings in the model which needs to be rectified to make it competitive in the market. Additional improvements are suggested to make the model more attractive over other existing scooters. In our design improvements, we intended not to make changes in relative positions of the engine and related accessories. We will consider each component of the scooter separately to provide a better understanding of the proposed improvements.

Seat

In our improved model, we have extended the seat towards stepni so that the gap between the seat and stepni is minimized. This will not only provide more space but also better support for the person sitting at the back. This arrangement also enables us to shorten the length of the plates supporting the stepni and thus increasing its strength properties. The improvement has been efficiently utilized by using a pipe support in place of the plate support for the stepni as shown in the figures 4.1. Seat-lock position has been changed to side of the seat instead of at the back of the seat. So the seat-lock is easily accessible in our improved model.

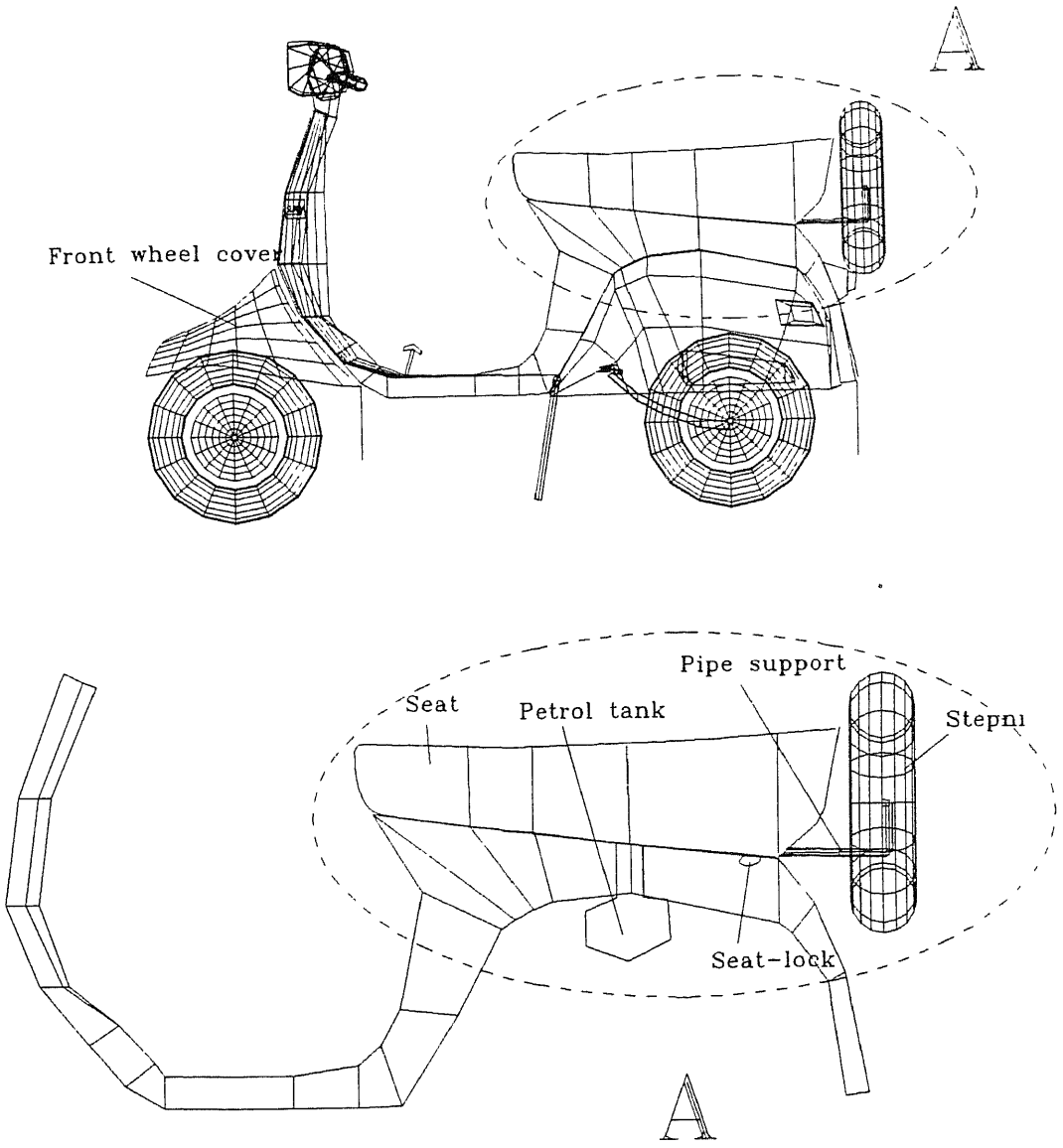


Fig. 4.1 Seat and stepni in improved design

Side-cover

Existing side cover totally misfits with rest of the body of the scooter if seen aesthetically. A new side cover shape is proposed. Side-view, top-view and rear-view of the proposed side-cover are shown in figures 4.1, 4.2 and 4.3 respectively. Engine size and other internal parts which are covered inside the side cover has been considered so that no change is required in the internal parts. The prime consideration for the design has been to get a shape which would fit well with the rest of the scooter. The back side indicators have also been fitted in the side cover to have better visibility of lights from distance. At the place where back side indicators are fitted, the side cover makes such an angle that makes the indicators easily visible from the back as well as the side. The visibility angle of back side-indicators in the improved model is 195 degrees as shown in figure 4.2. No fluid mechanics study is performed to guide the shape design simply because Indian roads are not suitable for high speeds.

Main front body

Tapering of this part at the top portion has been reduced so that the handle does not look comparatively large (figure 4.4). Second major change is done at the front plate by extending it sideways(see figure 4.5). This enhances the beauty of the scooter. It also gives the rider a psychological effect of having a protection from the sides. A portion of front side indicator also lies on this extended portion. This increases the indicators

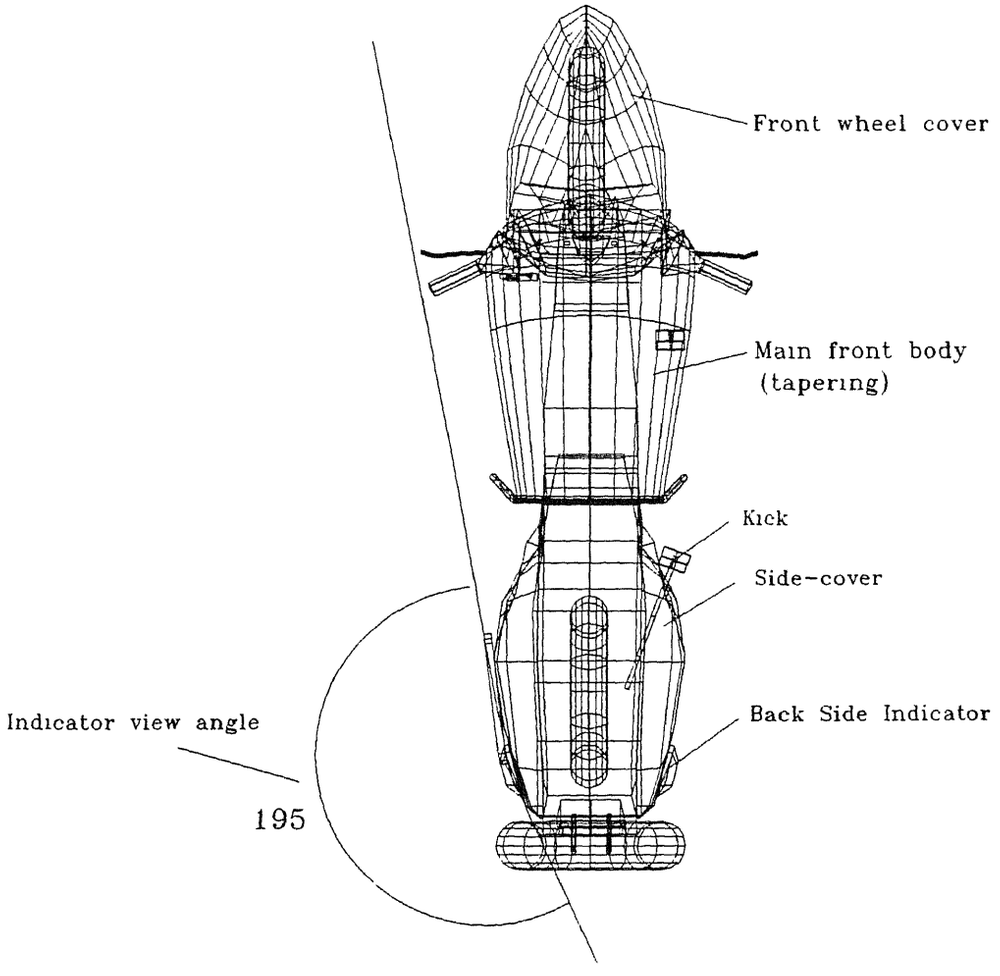


Fig. 4.2 Top view of improved design

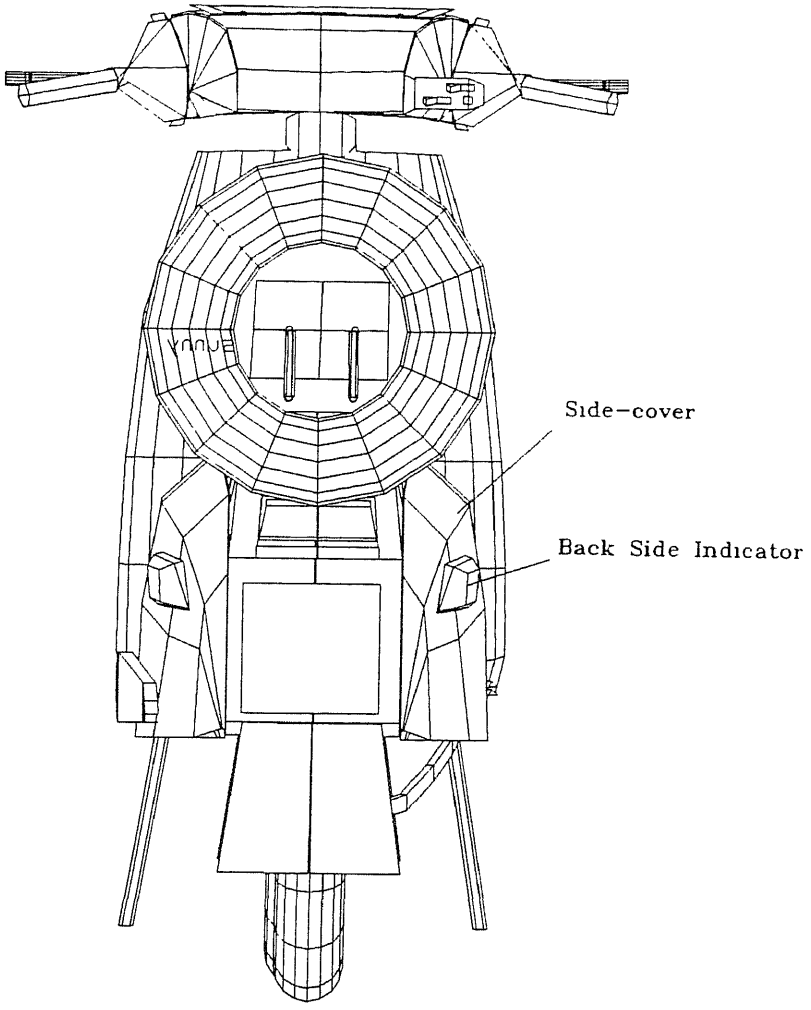


Fig. 4.3 Rear view of improved design

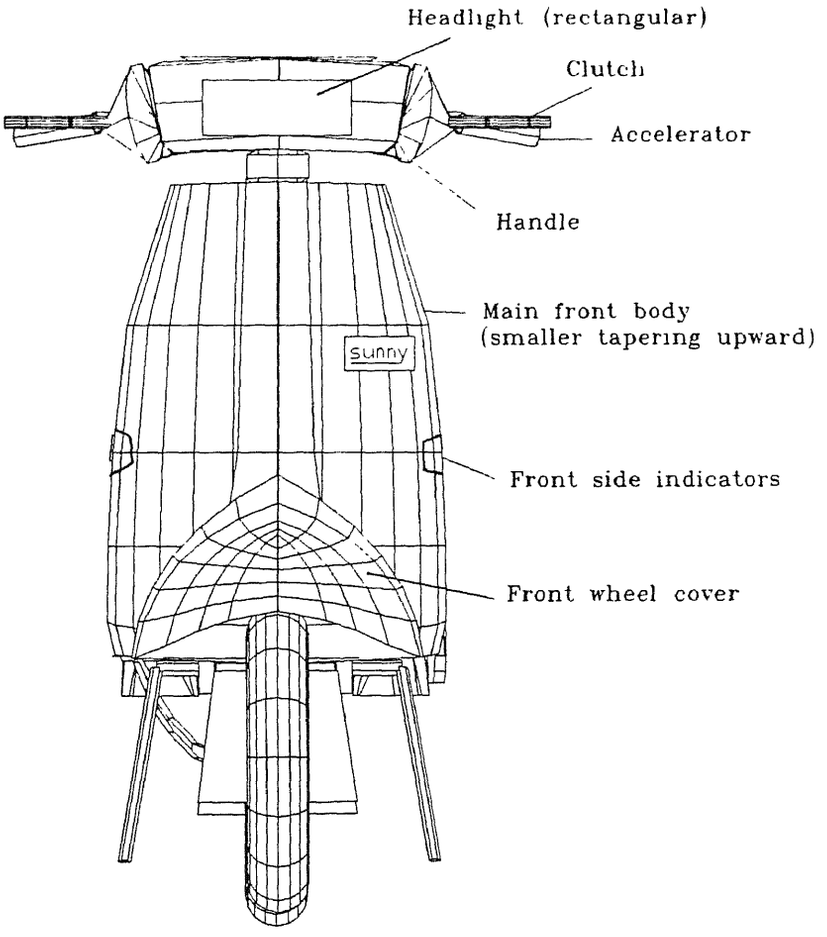


Fig. 4.4 Front view of improved design

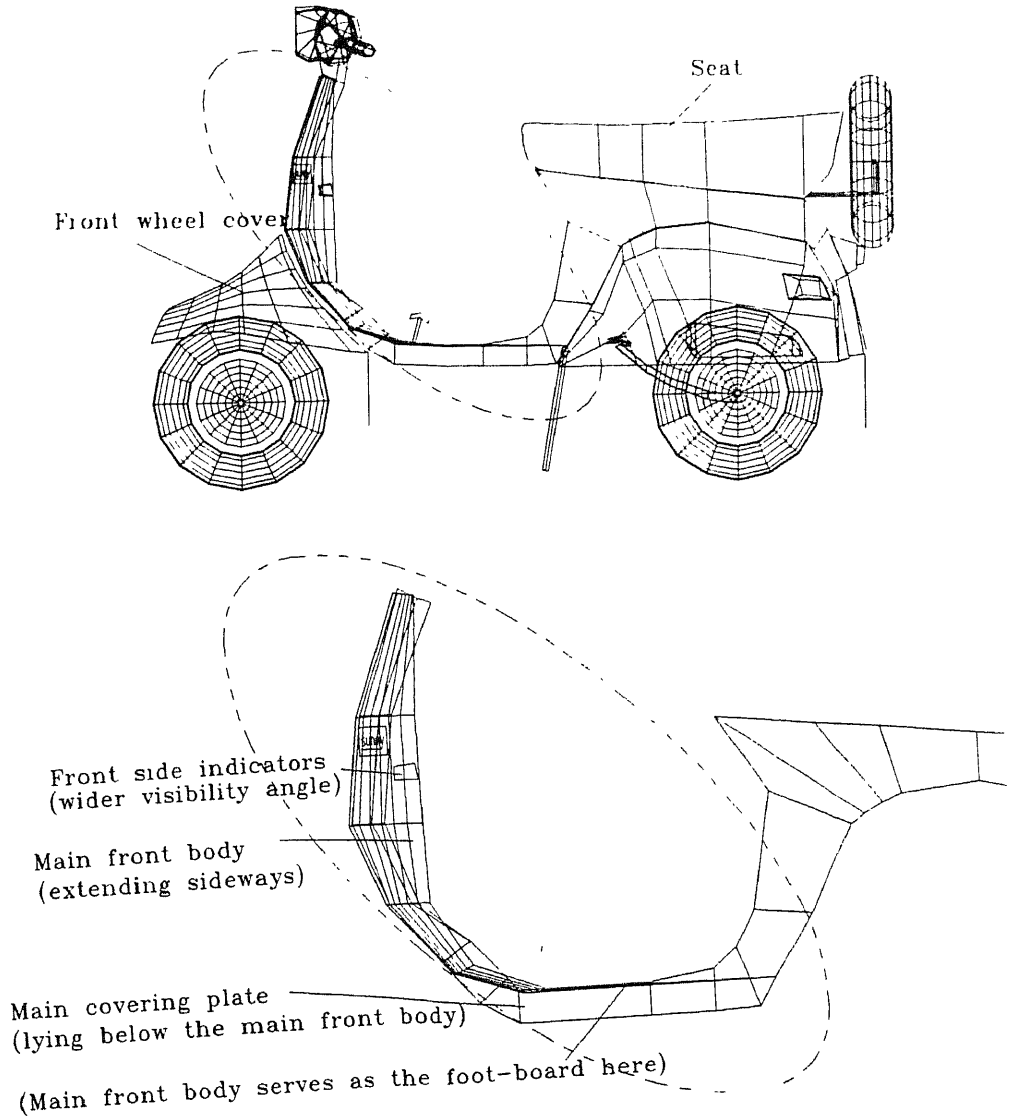


Fig. 4.5 Front cover and related components in improved design

visibility angle. So the vulnerable projection of the indicator lights which existed in the model is eliminated. Third improvement done is the tapering of front plate at the back portion (figure 4.2). This tapering aligns the front and side cover improving it aesthetically as shown in the figure 4.2. The improvement has also been used to reduce the projection of kick sideways. Since front body is the most crucial part for the beauty of the scooter, improved logos and the coloured lines are also suggested.

Main covering plate

A very crucial change is done in this part. This part is designed to have the front main cover lie to above it making the complete foot board flat (figure 4.5). Therefore, its height is increased so that it satisfies the ergonomics factors described in the previous chapter. Its seat base has been increased to accommodate the increase in seat length as shown in figure 4.5.

Front wheel cover

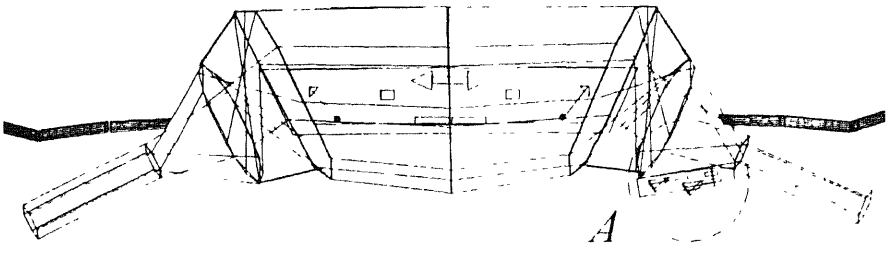
A totally new shape is given to this part . The main idea is to give a blending effect with the front plate in all the three views namely top view, side view, and front view. All the three views are shown in figures 4.2, 4.1, 4.4. Care has been taken, despite increased dimensions, to not foul with the front plate while moving the handle. For this, the basic dimensions have been taken from the existing scooter. Our design had been further tested by simulating the effect of rotation of the wheel cover using AutoCAD.

Handle

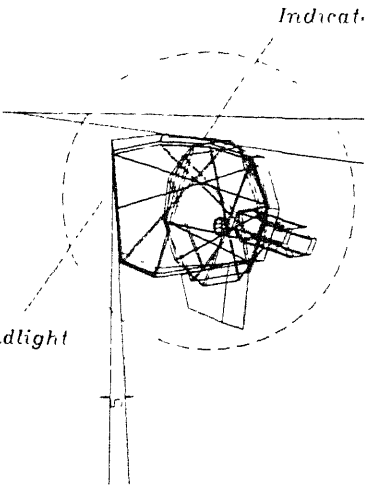
The design of the handle enhances the beauty of a scooter along with the functioning. We have incorporated the best possible innovative design in the existing scooter by synthesizing the old and new design elements . We had made the headlight style and the central portion of the handle somewhat close to the LML scooter. LML Select is chosen as our basic model after comprehensive study and market survey. The head light is made somewhat rectangular and is made five degrees inclined downward from the horizontal. This inclination value had been determined in the ergonomics study on the existing scooter. The angle of inclination from the horizontal of the panel containing various indicators is kept nine degrees which is also calculated in the ergonomics study in chapter 3. The handle is shown in figure 4.6 and a separate enlarged view of the indicator panel is also shown in the figure. The indicator arrows, fuel level indicator, speedometer, milo meter, side-indicator and headlight-indicator are incorporated in a symmetrical manner tc give it better look as shown. A major improvement is made in the switch board which contains a horn switch, a side indicator switch, and a headlight switch. Enlarged view of switch board is also shown in figure 4.6.

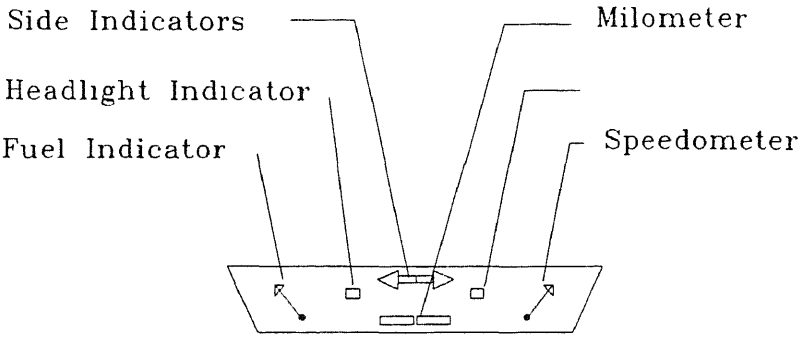
Summary

In the previous chapters we have performed ergonomics study and compared the existing model with most popular Indian scooters. In this chapter we have tried to remove the shortcomings found ir the existing model. An improved design of different components are

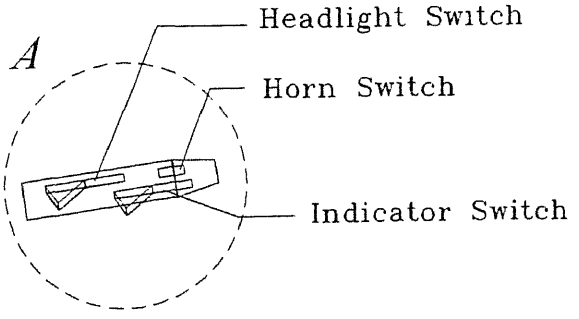


Handle



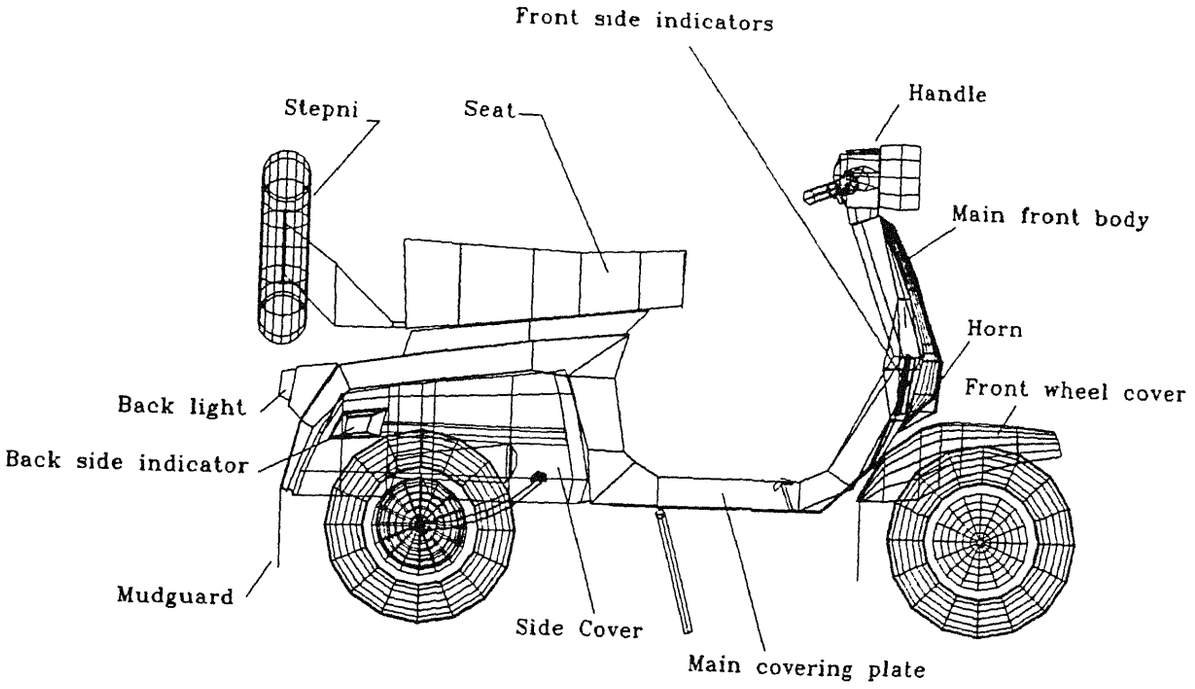


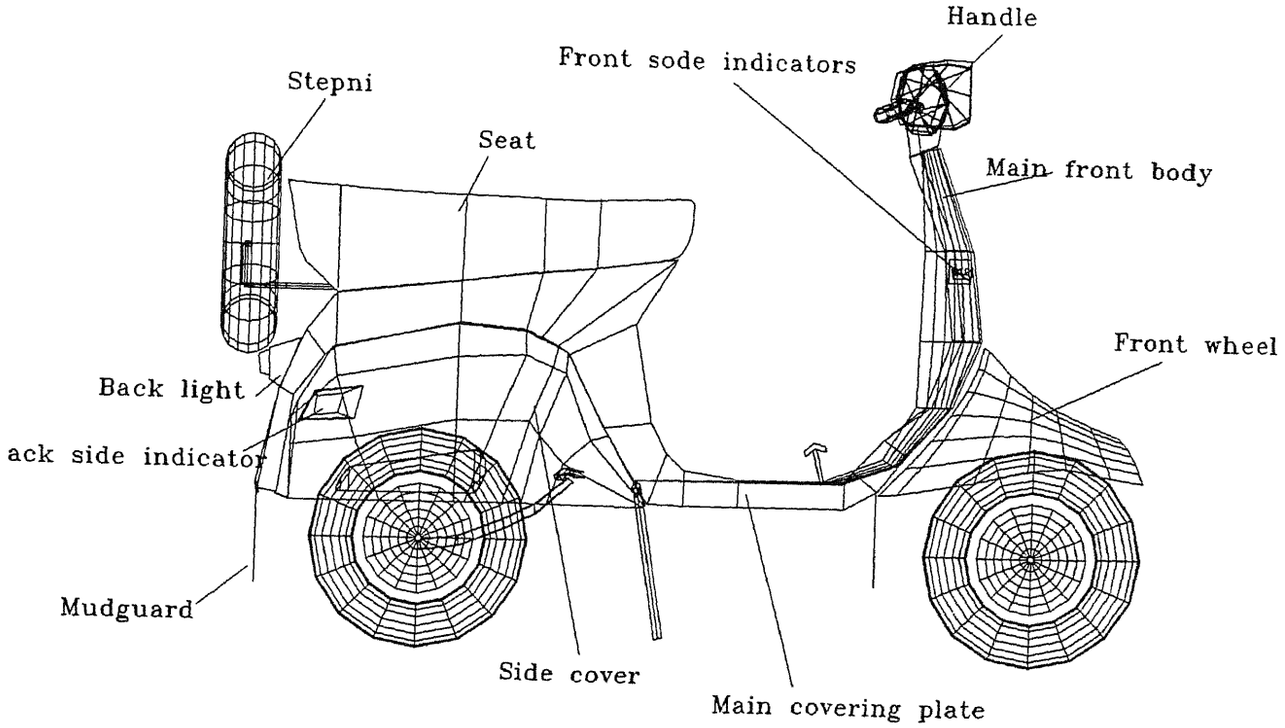
Indicator Panel



Switch Board

Fig. 4.6 Handle and its parts in improved design


Front side indicators
Handle
Stepni
Seat
Main front body
Horn
Front wheel cover
Back light
Back side indicator
Mudguard
Side Cover
Main covering plate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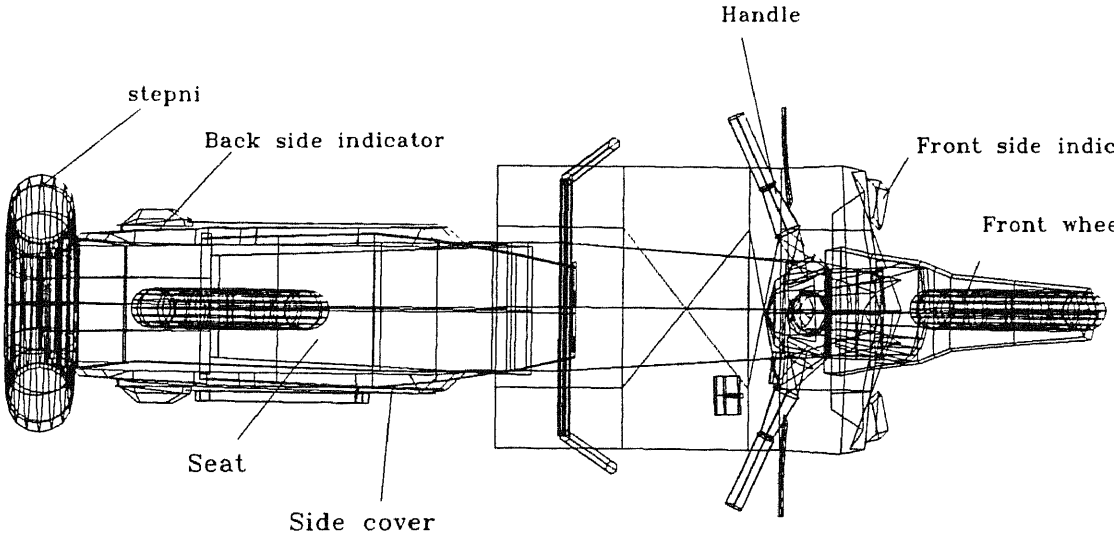
Side cover
Main covering plate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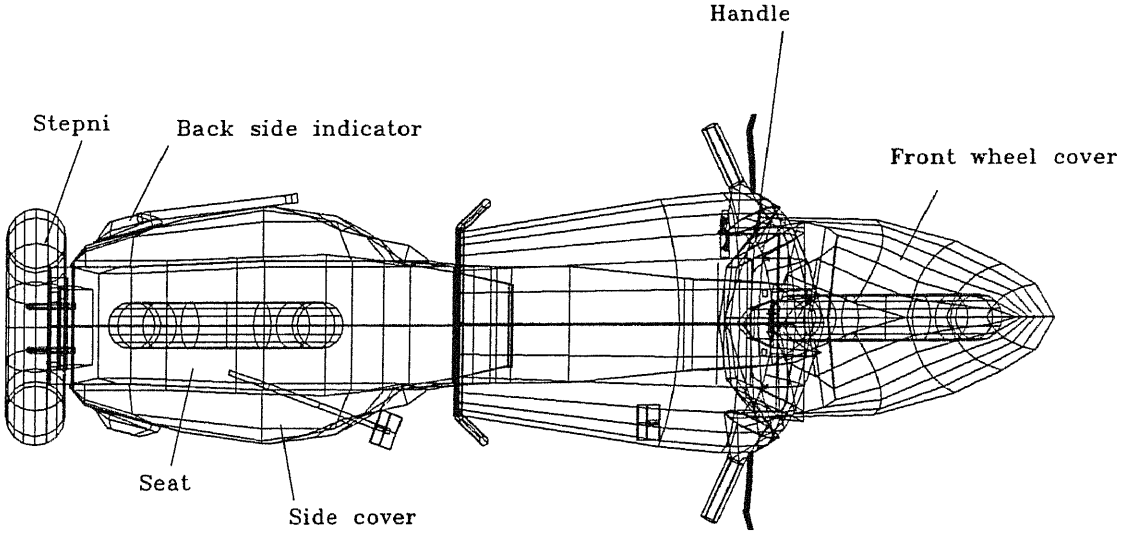
Front wheel c
Seat
Side cover


Handle
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Back side indicator
Front wheel cover
Seat
Side cover

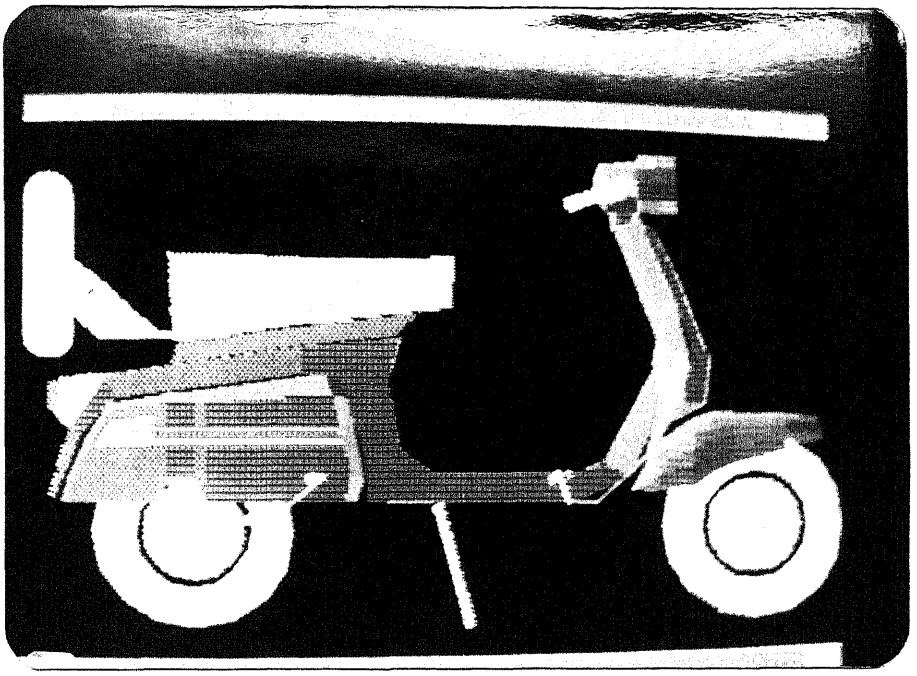

Fig 4.9(a) Side view of existing Sunny-FR scooter

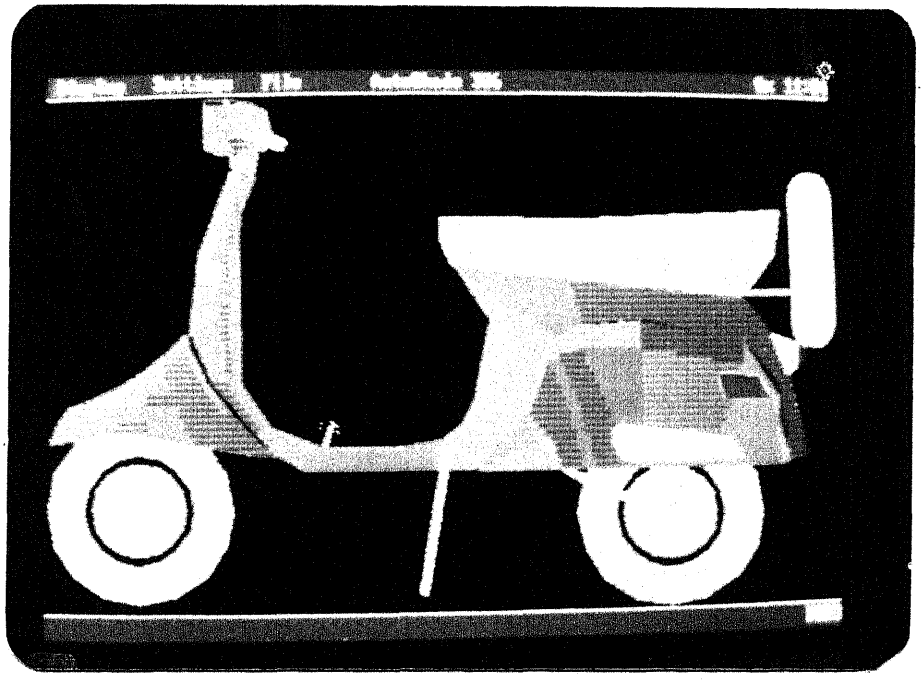

Fig 4.9(b) Side view of improved model

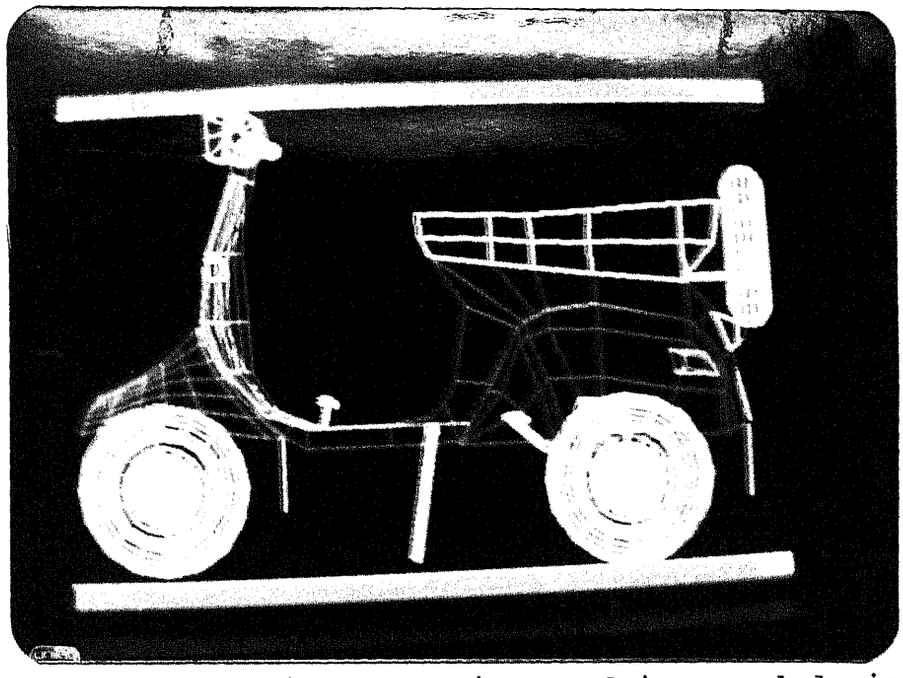

Fig 4.10(a) Wire-frame image of improved design

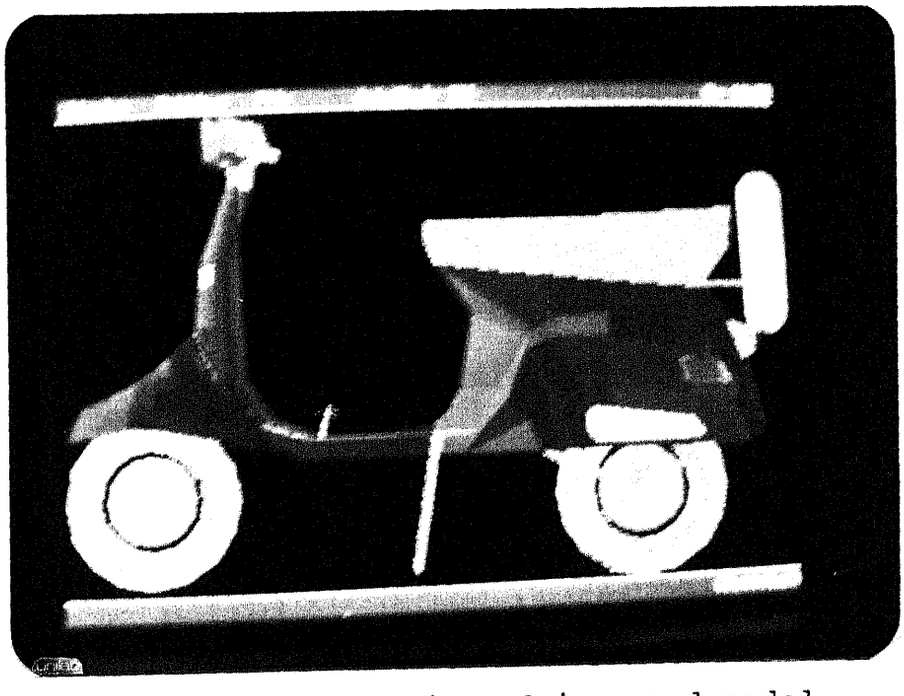

Fig 4.10(b) Rendered view of improved model

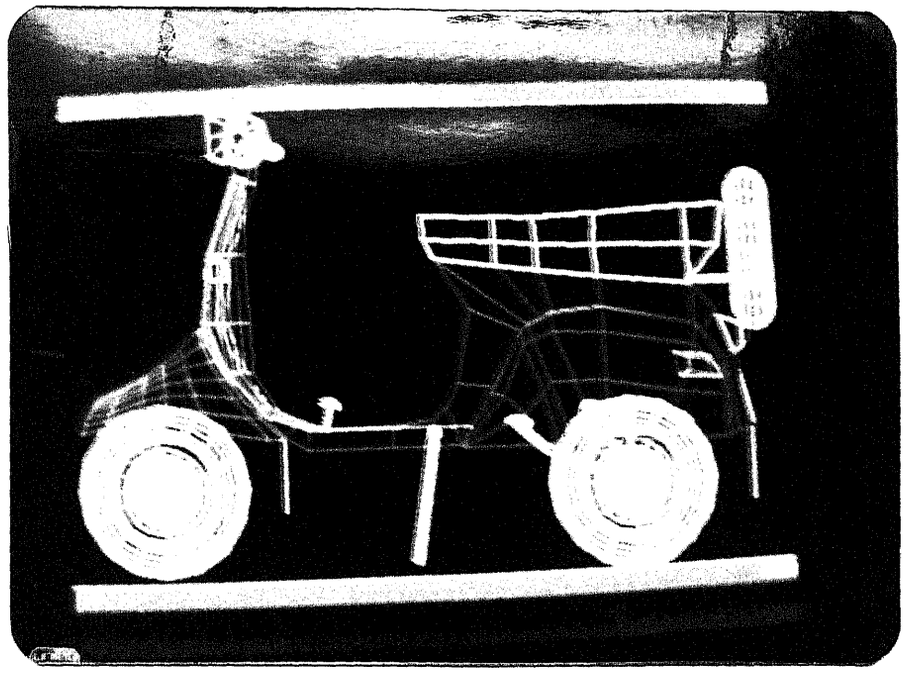

Fig 4.10(a) Wire-frame image of improved design

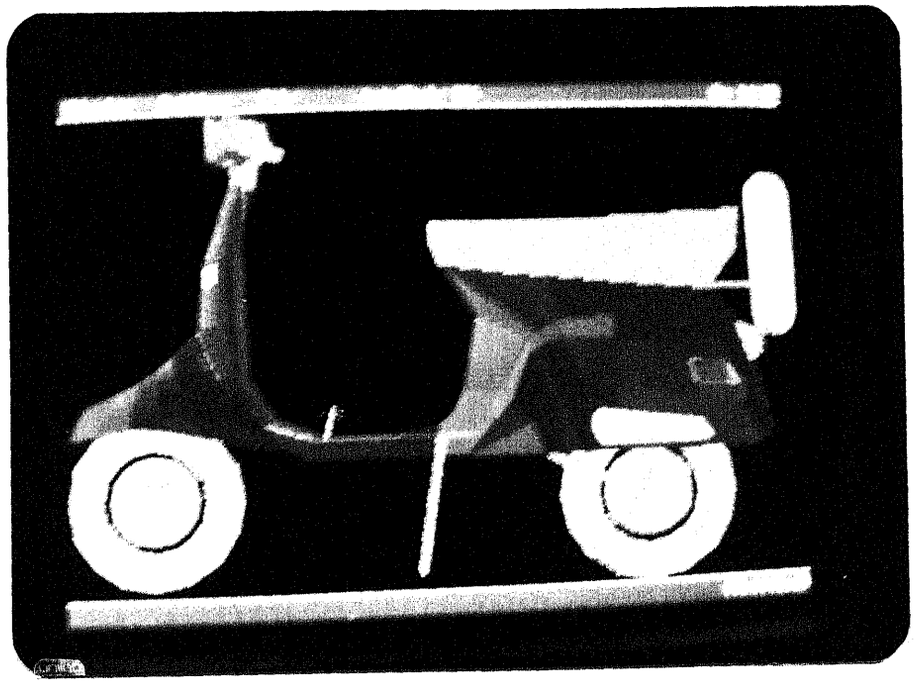

Fig 4.10(b) Rendered view of improved model

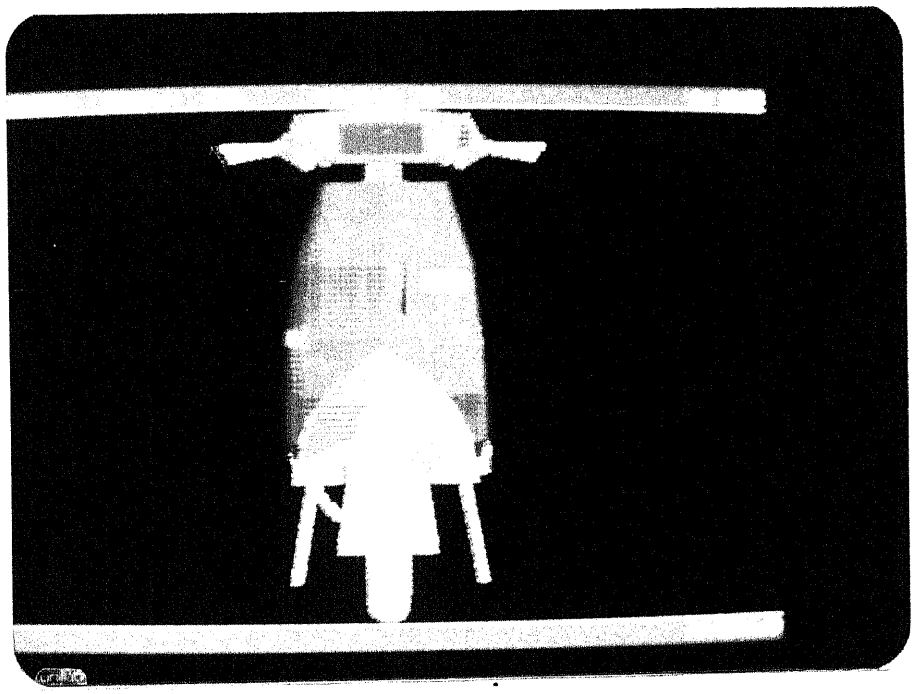

Fig 4.11 Front view of improved model

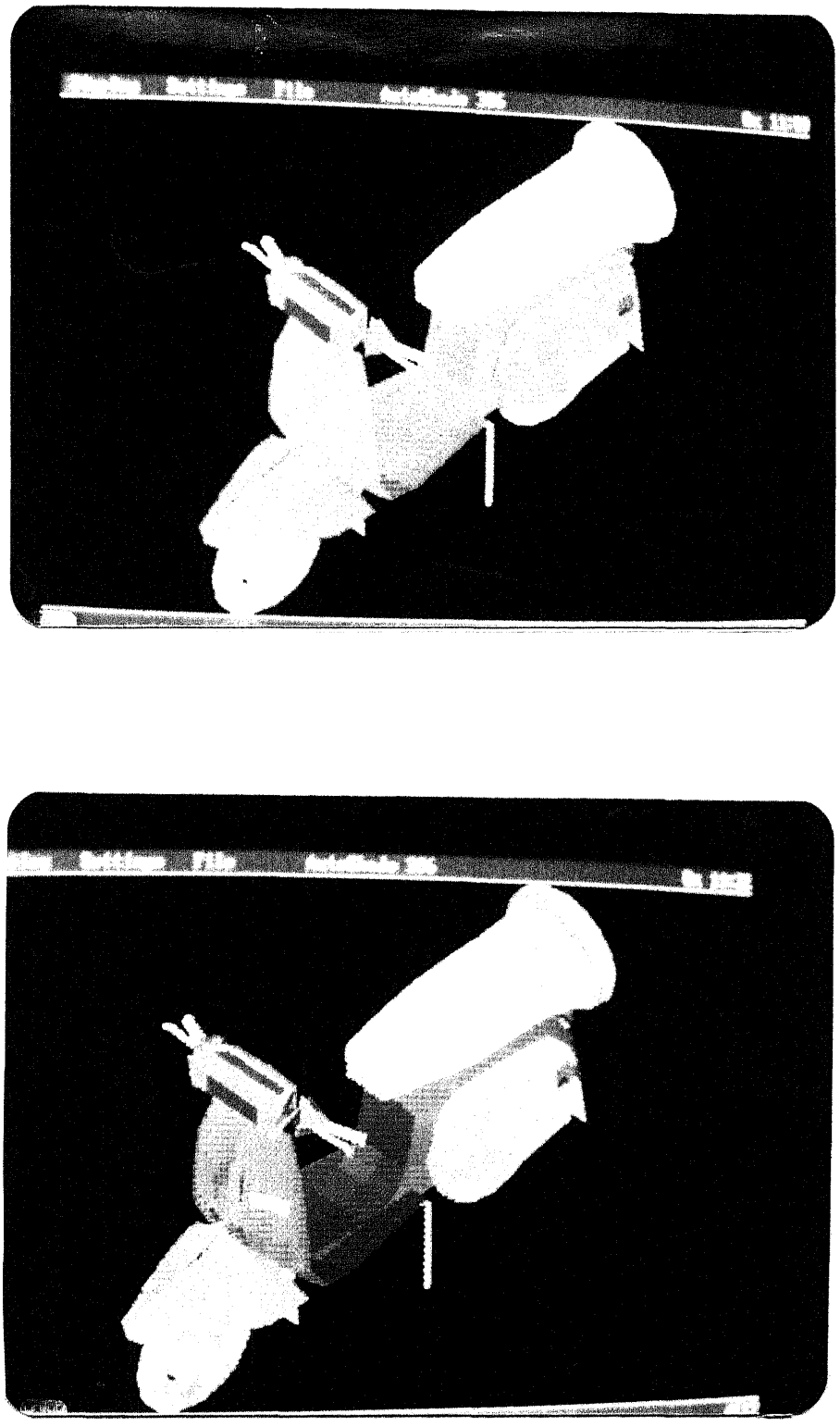

Fig 4.12 Isometric views of improved model in different colours

suggested. To have a better idea of the suggested improvements, side views of existing and improved model of Sunny-FR are shown in figure 4.7 and top views are shown in figure 4.8.

CHAPTER 5

CONCLUSIONS

In this thesis, we have presented ergonomics, aesthetics, and market studies on scooter design and subsequently suggested improvements to the existing model of Sunny-FR scooter, a product of Scooter India Limited. All the drawings of the design are achieved using AutoCAD. Every part is designed separately and then assembled together to get the complete model of the scooter. Most parts are generated through script files so that the drawing procedure and data are hard-copied into files for future generation. This is an useful way of creating drawings, which can be later used in manufacturing the vehicle and also in further improving the proposed design. AutoCAD displaying facilities are rigorously used for checking the misfit between components. This is also useful in giving the final touches to the design and thus providing the accuracy required in manufacturing. The displaying facility is also used in the ergonomics study of the scooter. Thereafter, AutoShade is used in rendering the drawings generated using AutoCAD package. This is very useful in providing realistic view of the designed scooter. This also gives us opportunity to choose different colour shades.

In reaching to the final design of the scooter, we have gone through many revisions. Some of the important intermediate designs are also shown in figures and the script files of various components are also provided.

Two wheelers are used worldwide and many companies are

manufacturers are coming up with changes in shape and facilities in the scooter quite frequently to attract the customers. But our study is mostly confined for the scooters to be used in India. In the thesis, earnest effort is done to make the best design of the scooter suitable to present trend in Indian market. But things are bound to change and improvements may be required in this proposed design in future. In this thesis, design is done in such a manner that the improvements can be easily done. In fact, our final design has been evolved by improvements in various stages in intermediate designs. No effect is made to achieve an optimal design from overall manufacturing cost point of view. The emphasis of this thesis is given to suggest improvements on the existing model of SUNNY-FR scooter. Any effect of a design for manufacturability requires extensive interaction with industries and knowledge of various cost factors such as die making cost, material cost, labour cost etc. With the availability of these inputs from the industries, this work can be extended to achieve an optimal design in the future. One final comment about this work is that stress analysis is not performed due to time constraint, but since the design material and overall size and position of the components are not changed in the proposed design, the design can be considered to be as safe as the original model.

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